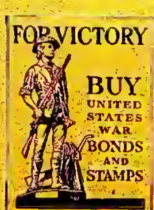
COMMUNICATIONS

RADIO ENGINEERING

PACK COMMUNICATIONS SYSTEM FOR FIRE FIGHTERS

DESIGN FACTORS IN AIRCRAFT RECEIVERS

FILAMENT VOLTAGE CONTROL AND TUBE LIFE



DECEMBER

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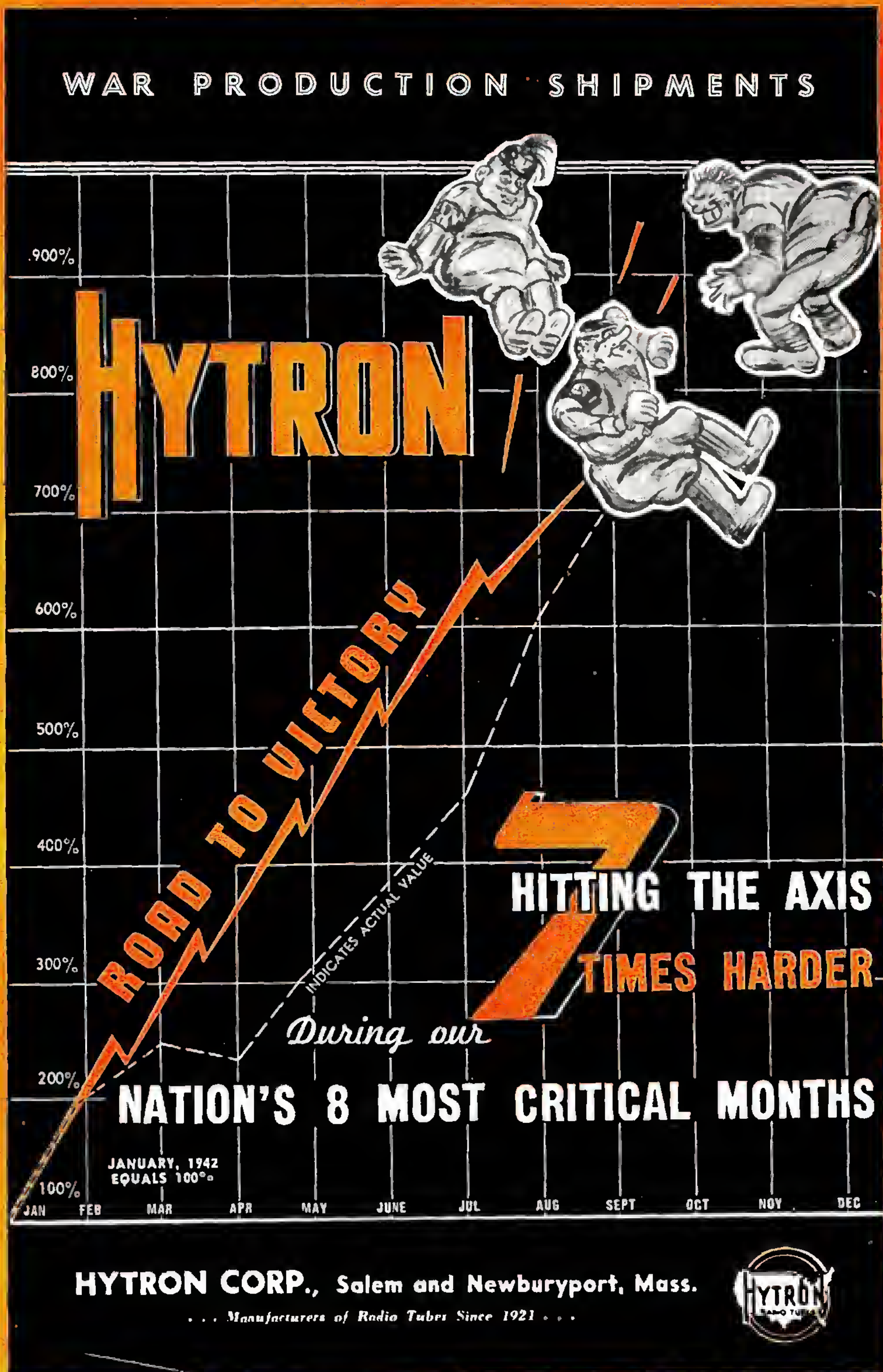

WAR PRODUCTION SHIPMENTS
HYTRON
ROAD TO VICTORY
INDICATES ACTUAL VALUE
HITTING THE AXIS
7
TIMES HARDER
During our
NATION'S 8 MOST CRITICAL MONTHS
JANUARY, 1942 EQUALS 100%
900%
800%
700%
600%
500%
400%
300%
200%
100%
JAN FEB MAR APR MAY JUNE JUL AUG SEPT OCT NOV DEC
HYTRON CORP., Salem and Newburyport, Mass.
. . . Manufacturers of Radio Tubes Since 1921 . . .
HYTRON

LEWIS WINNER, Editor
F. WALEN, Associate Editor

We See...

COMMUNICATIONS IS A DEFENSE INDUSTRY, Washington has ruled. This important statement results from an opinion rendered by the President's committee on fair employment practice by the general counsel of WMC, that was based on an interpretation of Executive order 8802. Thus all those engaged in broadcast companies and stations will receive defense industry recognition. With this ruling and the awarding of the AA-1 rating for replacements, *Communications* assumes one of the most powerful roles in our National life today!

THAT FCC SURPLUS SURVEY among the broadcast stations should furnish some startling facts. The questionnaire requests data on the size, power, frequency, range emission, scale, etc., and condition of all surplus equipment. And if the equipment is used, the licensees have been asked to state whether or not it is in serviceable condition, requires minor or major repairs, etc. That this is not a selling program at the present moment is emphasized by the statement . . . "selling prices should not be quoted . . . it is understood that the listing of the information sought does not necessarily constitute an offer to sell . . . it is merely a means of making the information available to interested parties." When the survey has been completed by the Surplus Equipment Section of the engineering department of the Commission, the data will be analyzed, catalogued and distributed as a Federal publication. What a "must" book this will be for every station library!

SUBSTANTIAL TUBE REBUILDING programs are swinging along in the plants of nearly half of the tube-makers. And it appears as if all will be contributing to the program before the Spring. It's an appropriate move and of tremendous assistance to the civil and military, relieving as it does those manufacturing facilities required for new tube building. We hope that other types, in addition to the triodes, will be included in programs of rebuilding.
—L. W.

COMMUNICATIONS

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DECEMBER, 1942

VOLUME 22 NUMBER 12

COVER ILLUSTRATION

Fire fighting in New York City with the use of a specially developed pack communication unit. These packs are carried right into the hazardous fire areas to provide firemen with a detailed report of how to best fight the flames, what points of danger to avoid, etc. A complete description of this apparatus appears in this issue on pages 7, 8, 9, 10, 11, 42 and 43.

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Glass tubing becomes finished filament stem with leads sealed in position on this special upright lathe.

VACUUM TUBE *Performance* IN THE MAKING...

"Trifles make perfection and perfection is no trifle"*... The tiniest part of every Eimac tube is a *"tremendous* trifle," handled with the utmost care . . . the greatest skill. In an Eimac 304T tube there are more than fifty separate parts which pass through many fabricating operations before they are ready to be assembled into the tube. Through all these steps great care is taken to hold the dimensions of each part to a very close tolerance... to make every welded joint perfectly solid. Such painstaking care in the fabricating of each part, plus the achievement of extremely high vacuum... helps provide the outstanding performance capabilities which have made Eimac tubes famous. In the toughest jobs you'll find Eimac tubes in the key sockets most every time. They are first choice among the leading engineers throughout the world.

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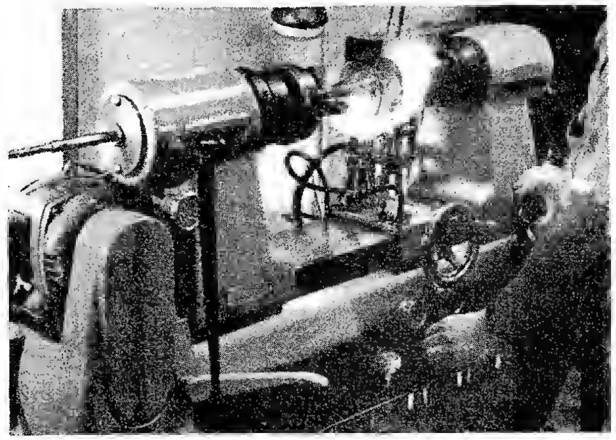
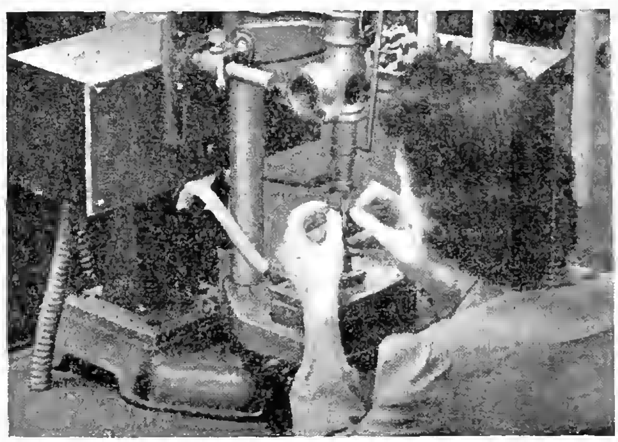


Glass bulbs are annealed after tube is fully assembled. This operation relieves stress and strain in the glass itself which may have been induced during manufacture.



Deft fingers work steadily with tiny parts which are faultlessly produced. Here plate sections are being welded together in routine production.

The eyes of all America are upon the United States Treasury Roll of Honor appearing in the "Payroll Savings News." For copy write War Savings Staff, Treasury Department, Washington, D. C.

NEW 10% WAR BOND DRIVES SWELL TREASURY HONOR ROLL

HOW TO "TOP THAT 10% BY NEW YEAR'S"

Out of the 13 labor-management conferences sponsored by the National Committee for Payroll Savings and conducted by the Treasury Department throughout the Nation has come this formula for reaching the 10% of gross payroll War Bond objective:

1. ***Decide to get 10%.***
   It has been the Treasury experience wherever management and labor have gotten together and decided the job could be done, the job was done.
2. ***Get a committee of labor and management to work out details for solicitation.***
   a. They, in turn, will appoint captain-leaders or chairmen who will be responsible for actual solicitation of no more than 10 workers.
   b. A card should be prepared for each and every worker with his name on it.
   c. An estimate should be made of the possible amount each worker can set aside so that an "over-all" of 10% is achieved. Some may not be able to set aside 10%, others can save more.
3. ***Set aside a date to start the drive.***
4. ***There should be little or no time between the announcement of the drive and the drive itself.***
   The drive should last not over 1 week.
5. The opening of the drive may be through a talk, a rally, or just a plain announcement in each department.
6. Schedule competition between departments; show progress charts daily.
7. Set as a goal the Treasury flag with a "T."

As of today, more than 20,000 firms of all sizes have reached the "Honor Roll" goal of at least 10% of the gross payroll in War Bonds. This is a glorious testimony to the voluntary American way of facing emergencies.

But there is still more to be done. By January 1st, 1943, the Treasury hopes to raise participation from the present total of around 20,000,000 employees investing an average of 8% of earnings to over 30,000,000 investing an average of at least 10% of earnings in War Bonds.

You are urged to set your own sights accordingly and to do all in your power to start the new year on the Roll of Honor, to give War Bonds for bonuses, and to purchase up to the limit, both personally and as a company, of Series F and G Bonds. (Remember that the new limitation of purchases of F and G Bonds in any one calendar year has been increased from $50,000 to $100,000.)

TIME IS SHORT. Our country is counting on you to—

"TOP THAT 10% BY NEW YEAR'S"

EVERYBODY EVERY PAYDAY AT LEAST 10%

Save with War Savings Bonds

This space is a Contribution to America's All-Out War Effort by COMMUNICATIONS

COMMUNICATIONS

LEWIS WINNER, Editor

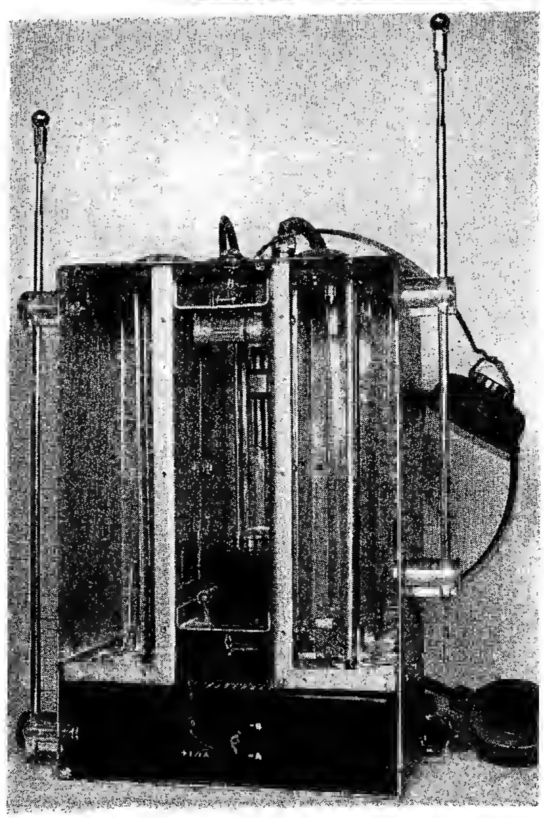
Pack Communications Equipment

FOR FIRE FIGHTING

Receiver, Transmitter and Auxiliary Units Expressly Developed to Meet Stringent Requisites of Fighting Fires Anywhere.

by ART H. MEYERSON

New York Fire Department Radio Laboratory



Figures 1 and 2. Art H. Meyerson operating the receive-transmit-volume control unit of the pack radio used by the New York Fire Department. Below appears an interior view of this unusually compact transmitter and receiver, that has an operational life of approximately 100 hours.

ABOUT ten years ago, radio made its first practical appearance in the Fire Department. Its use was limited to communication between fire fighting units and the Telegraph Bureau, which is the internal communication system of the fire service. The need for radio communication was particularly acute in the marine fire branch. With its advent this branch could be apprised of conditions at a fire before its arrival, from the preliminary reports sent in to the Telegraph Bureau by land companies. Long, unnecessary runs were thus avoided, and marine units were always in service, even when away from their berths.

On land, radio communication has served similarly. The Telegraph Bureau maintains communication with fire fighting units and is immediately notified of conditions at the scene of the fire, or in some cases, the need for additional or special apparatus.

However, there was a further problem . . . communication at the scene of the fire between units operating in the fire area. The methods previously used were limited. Fire chiefs in charge of the fire depended on aides to cover the fire area afoot. They in turn reported to the chiefs the conditions found at various points. A short explanation of fire-fighting procedure will help clarify this.

Fires are known by their "exposures." An exposure is a possible direction for extension of the fire area. The normal procedure is to station hose companies at all these exposures to prevent extension, while other companies attack the fire itself and attempt to bring it under control. Conditions at a fire change rapidly, and quick communication is the crux of fire fighting strategy. New danger points must be instantly covered and coordination of operating units facilitated. Another grave problem is communication in skyscrapers, where fires occur on upper floors and information must be relayed between operating and ground units.

It can be readily seen from the above that the pack radio was the answer to this problem. But, although many models were submitted by radio manufacturers, none were found adequate to the needs of the New York Fire Department. Radio manufacturers did not seem to understand the specific problems involved in the design of a fire-fighting pack radio.

In September, 1939, Samuel N. Marmatuck* and the writer, as members of the New York Fire Department who had seen active fire duty and had the necessary technical background, were detailed by the department to investigate the problems involved in the design of a fire-fighting pack radio.

Before any development work could be instituted, a list of design "musts" were prepared. These were:

1)—Light weight.
2)—Compact.
3)—Simple to operate.
4)—Long operational life.
5)—Freedom of operator's hands.

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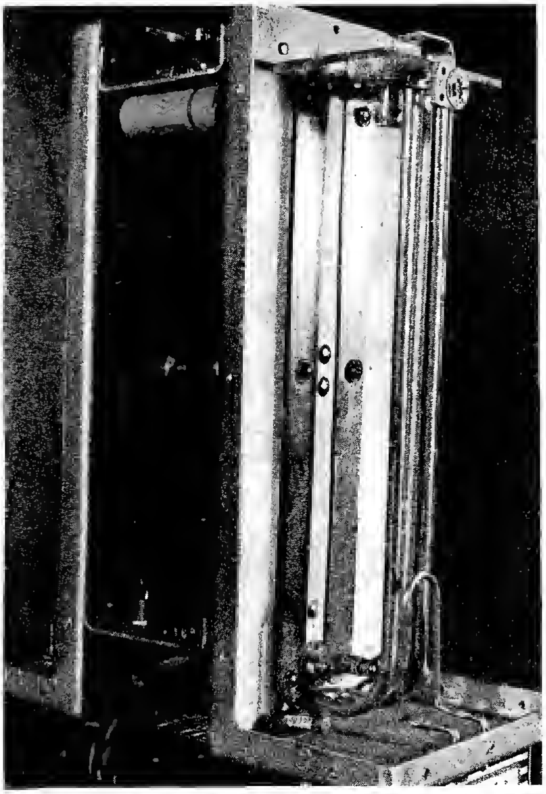
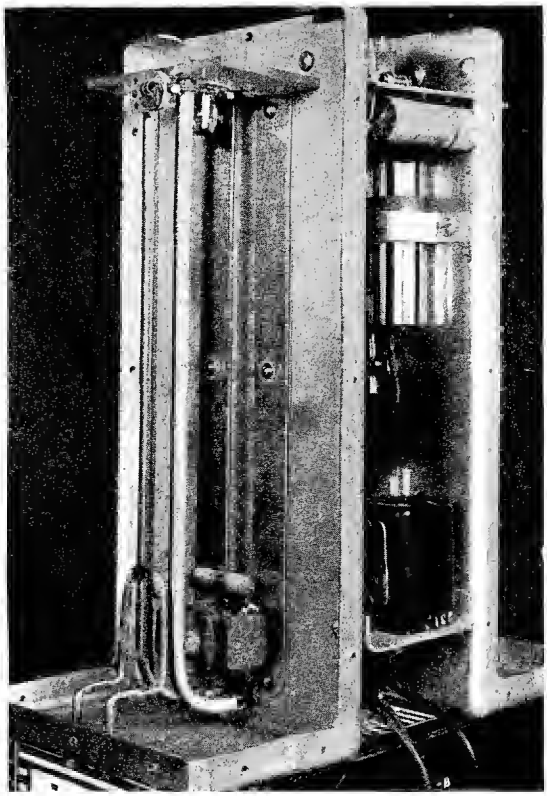
*The material for this paper has been compiled from notes resulting from experiments conducted by the writer and Mr. Harmatuk, who is now a Lieutenant in the U. S. Army Air Force.





Figures 3, 4 and 5.
In Figure 3, top, transmitting portion of pack unit. Figure 4, below, receiver section. Here, a self quenched s-r detector that depends on multiple oscillation at two different frequencies is used. At right, Figure 5, the effects of the coupling capacitance between the tube elements and tank circuit in Meissner circuit and diameter of feed line on both tube loading capacitance and power output, are illustrated. Zero, under FDEV equals fundamental frequency. FDEV equals kc deviation.

6)—Pack to pack operation.
7)—Sturdy, fool proof and fairly waterproof.
8)—It must be dependable.
9)—It must cover the fire area.

Operating Frequency First Problem

Our first problem was operating frequency. It was decided to use the u-h-f band somewhere between 100 and 250 megacycles because circuit constants were small and a satisfactory antenna would have reasonable dimensions. Later, the freqeuncy of 250 megacycles was dropped in favor of 100 to 135 megacycles because of limitations of tubes and measuring devices, and circuit instability.

Our original assigned frequency was 137.580 megacycles. This was later changed by the FCC to 117.550 megacycles, our present frequency.

Current Model Extremely Compact

The current model weighs 13.5 pounds, and measures 9"x13½"x5". One control, easily accessible, turns the set on or off, switches from transmit-to-receive and regulates the volume on receive. The operational life is approximately 100 hours. Frequency stability is well within government regulations, ±.1%. It is mechanically very strong, waterproof and has never failed to operate at a fire. Operation is assured within a quarter mile area under the most adverse conditions. Under ideal conditions two-way communication has been maintained at a distance of 2½ miles.

The unit is composed of three sections: the receiver proper, the transmitter proper, and the common audio unit. We will discuss each section and its development in detail.

Before we could begin the development of either the receiver or transmitter it was necessary to decide the type of oscillator circuit best suited for either or both. Again a list of design "musts" was established. These were:

1)—Good frequency stability.
2)—Mechanical strength.
3)—Highest possible Q.
4)—Easy construction.
5)—Low losses.
6)—Easy to tune.

Coil, condenser combinations were tried and found inadequate. Next resonant, concentric, and folded lines were tried. Concentric lines were too bulky and hard to adjust. Folded lines were less bulky and had excellent frequency stability, but were very heavy and difficult to construct. Resonant lines were found to most nearly satisfy all six conditions.

Reukema's Formula Used

Reukema's formulae for optimum design of resonant lines were used. Optimum spacing D for ⅛λ shorted lines designed for maximum Q.

$$D = .0279\lambda^{5/6}$$

where D = distance between centers in cm.
λ = wave length in cm.

$\frac{D}{r} = 6.186$ for maximum Q where r = radius of conductor.

For our assigned frequency 117.550 mc or 255.21 cm.
r = .456 cm. or .18 inches.
D = 2.825 cm. or 1.11 inches.

In actual practice we use ¼" copper tubing spaced slightly over ¾". The line length is controlled by the input capacitance of the tube and the value of tuning capacitance. This latter value should be at least three times the tube input capacitance for circuit stability.

At first, straight resonant lines were

	Gc = 40 Pc = 40 Fc = *20		Gc = 165 Pc = 135 Fc = *20		Gc = 360 Pc = 340 F		Gc = 125 Pc = 140 Fc = *20		Gc = 60 Pc = 60 Fc = *12		Gc = 90 Pc = 90 Fc = *30	
TUBE NO.	F DEV	P.O. MW	F DEV	P.O.	F DEV	P.O.	F DEV	P.O.	F DEV	P.O.	F DEV	P.O.
1	0	95	0	65	0	71	0	124	0	65	0	133
2	120	162	200	187	160	200	160	270	140	137	80	275
3	440	193	600	193	640	172	540	234	480	141	480	306
4	460	79	600	104	640	141	580	141	500	69	520	152
5	480	137	600	135	680	141	600	185	520	101	520	193
6	580	141	720	141	800	173	720	217	620	108	640	200
7	760	53	880	40	1000	0	840	0	740	0	800	74
8	880	187	1100	200	1180	234	1040	350	960	173	1040	270
9	1000	95	1240	137	1320	141	1180	151	1080	101	1120	162
10	1040	95	1200	133	1320	141	1140	162	1040	86	1080	162

used (see 6A). After considerable experimentation this circuit was developed into circuit 6B, which is a resonant line adaptation of a Meissner oscillator.

Our first tuning condenser, used with resonant lines, was two circular plates, one stationary, the other fitted with a differential screw for micrometer advancement, and spring loaded. This was discarded, however, because contact resistance caused frequency instability and noise.

With the Meissner we use a midget trimmer condenser with a negative coefficient of expansion. Tuning methods will be further discussed at the conclusion of this article.

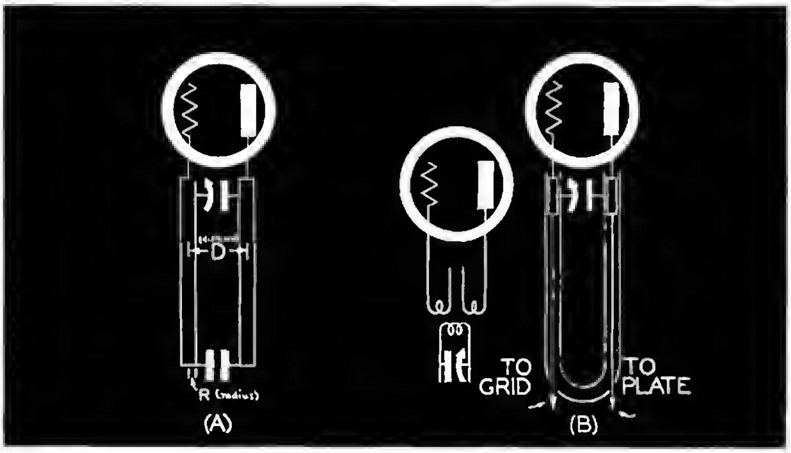
The resonant line adaptation of the Meissner circuit required some experimentation to determine the best value of coupling capacitance between the tube elements and the tank circuit. It was also determined that the ratio between the diameter of the feed line to the circuit elements and the inside diameter of the tank tubing, bore an important relationship to the amount of power developed in the tank. The accompanying charts* illustrate the effect of this capacitance and the diameter of the feed line on both frequency stability and power output. Ten different tubes were placed in the oscillator circuit in sequence; that is, according to their input capacitance. The difference in kc deviation was noted progressively from tube one to tube ten; also the maximum power output. This was done repeatedly for various values of G_c and P_c where G_c and P_c equal capacitance between the slug and the feed line to the tank circuit. The size of feed line was also varied from 30 wire to 12 wire.

From the charts it can be seen that the coupling capacitance determines the amount of tube loading due to input capacitance. In other words, this is a form of grid and plate stabilization. It also affects the available power output. The diameter of the inner conductor also affects the power output. The greater the ratio between the conductor diameter and the inner diameter of the tank coil, the more power the tube will deliver. This is probably due to the reduction of the distributed capacitance in the circuit. Shunt feeding of the grid and plate was tried, but was not as effective as running the leads through the tank coil. Another point is that lumping the coupling capacitance near the tuning condenser and the tube elements improves circuit performance. From our numerous experiments it was determined that the best apparent value of coupling capacitance for circuit stability and power transfer at our frequency (117.550 mc) lay somewhere between 75 and 125 mmfd.

*Approximately one hundred charts of this nature were prepared to exact the necessary data in this development procedure.

Figure 6

The two types of resonant lines that were studied in conjunction with the development work. At (A) is a straight resonant line system, while at (B) is a development of (A), or a resonant line adaptation of a Meissner oscillator. The latter was found to be best and was therefore adopted.



The Receiver

An investigation of super-regenerative detection showed two basic methods; self quenched and separately quenched. The separately-quenched circuit was eliminated because of increased circuit components.

There are two types of self quenched super-regenerative detectors (see Figure 7). Circuit A depends on the time constant of R_gC_g for the frequency of quenching action. Circuit B depends on multiple oscillation at two different frequencies. We decided to use circuit B after trying both because it was more stable and more easily adjusted. Circuit C shows circuit B adapted to a resonant line Meissner.

However, our job was not complete. We were interested in optimum design

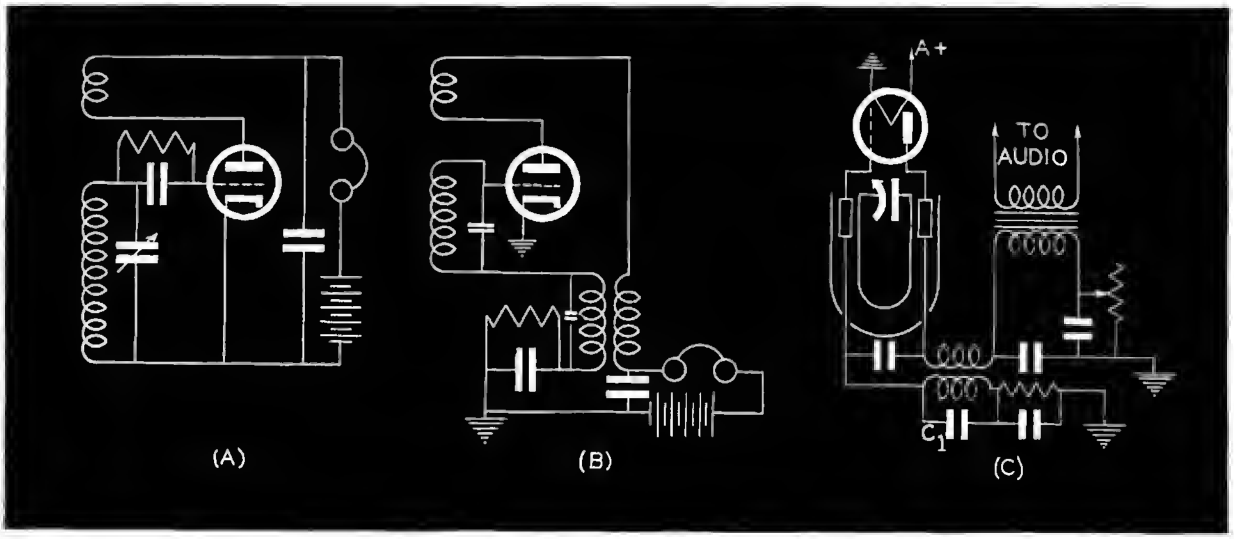
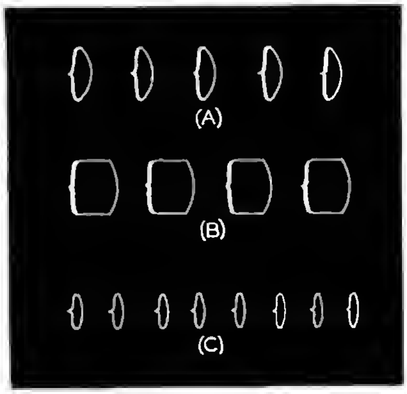


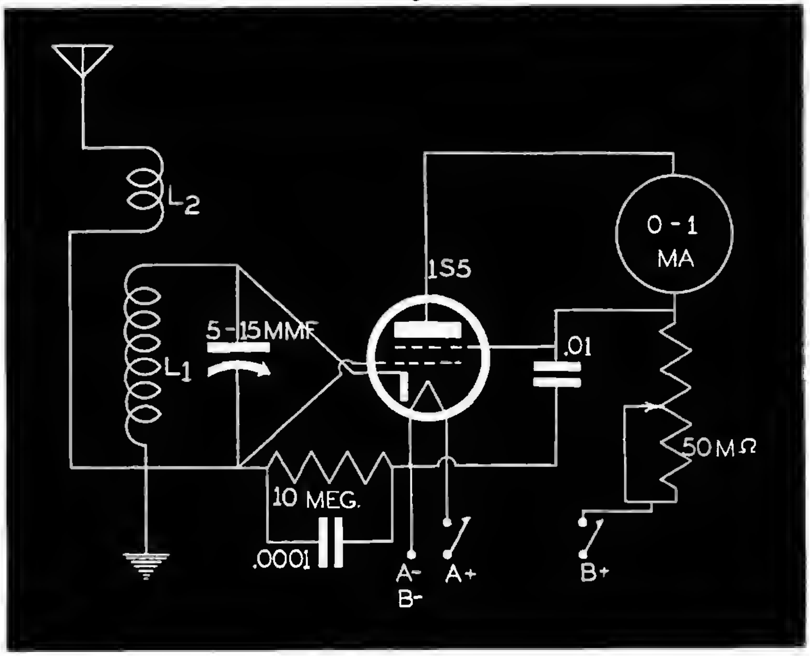
Figure 7

Self quenched super-regenerative detectors.

Figures 8 (left) and 9 (below)

At (A) left, appears the proper quench frequency as recorded on an oscilloscope. At (B), the quench frequency is too low, and at (C) it is too high. Below, a field strength meter specially developed to check on pack unit response.





for our frequency. The best quenching frequency for our assigned frequency had to be determined. This was done experimentally. An LC circuit tuned to our frequency was hooked up directly to the vertical deflection plates of our oscilloscope. This acted as a pickup loop for the radiated energy from our s-r detector which was closely coupled to it. The quenching frequency was varied and the results noted. For optimum design, the best quench frequency was that which showed maximum envelope amplitude for maximum number of envelopes. (See Figure 8.) This was found to be approximately 60 kc. Our next step was to determine the best value for C2. This is the r-f bypass for the audio end of the s-r detector. A modulated signal of very low intensity was picked up and C2 was varied for best results. The audio component was found to be at maximum between values of .0009 and .002 mfd., peaking sharply at .0015 mfd. The next step was to determine values for C3 and R1. R1 was varied between .025 and 10 megohms for values of C3 of .0001, .00025, .0005 and .001 mfd. The lowest value of s-r plate voltage was found to be with a .5 megohm for R1 and .00025 mfd. for C3. However, these values were not critical. It was found necessary to insert a 100 mmfd. condenser across the grid and plate terminals of the super-regenerative coil to increase its activity. Some important constructional details must be noted at this point. To keep r-f out of the filament legs, it is important that they be well bypassed. Condensers from the filament terminals to ground will not work. It is necessary that the voltage pass along the surface of the condenser. The fact that all leads must be short cannot be stressed too strongly. A common ground is also essential, since r-f will build up along even the shortest leads. The position of bypass condensers in relation to other circuit components is important. Silver mica condensers are superior to micas. Inductive coupling to the antenna is superior to capacitive coupling. This will be further explained under coupling methods. Antenna length is not critical. However, the more heavily the circuit is loaded by the antennna, the smoother will be the results and the greater the receiver sensitivity.

For example, our receiver will super-regenerate at 18 volts unloaded. We have found that by loading the circuit with the antenna so that super regeneration starts at a plate voltage of 60 volts, we get our best results. Another

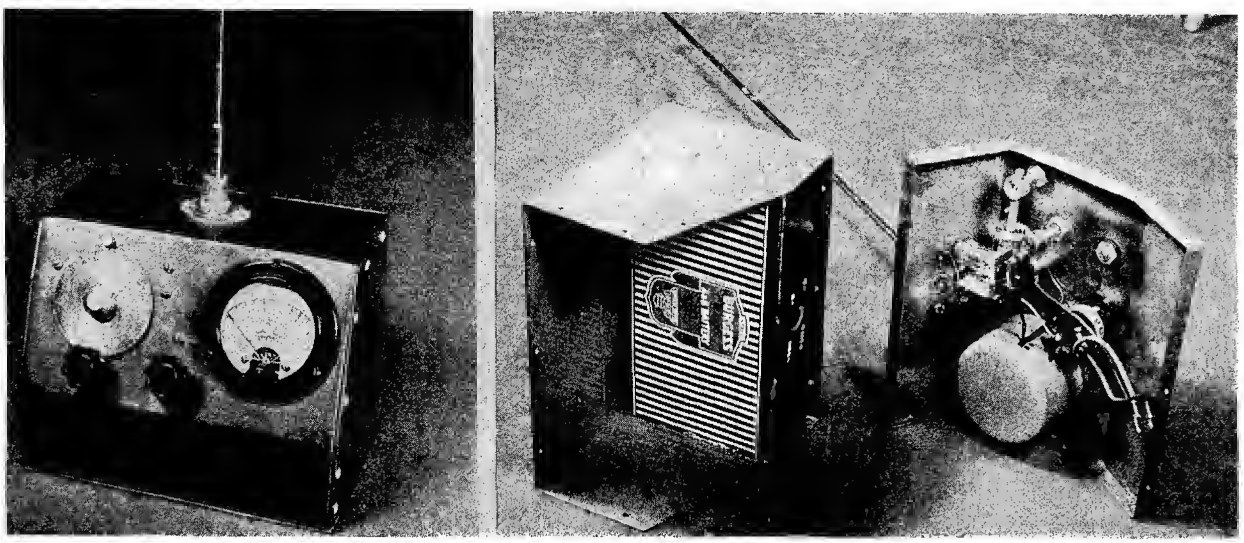


Figure 10

At extreme left, the field strength meter. At right an internal view of the device. This unique device will measure power output of the order of 50 milliwatts at a distance of 10 feet.

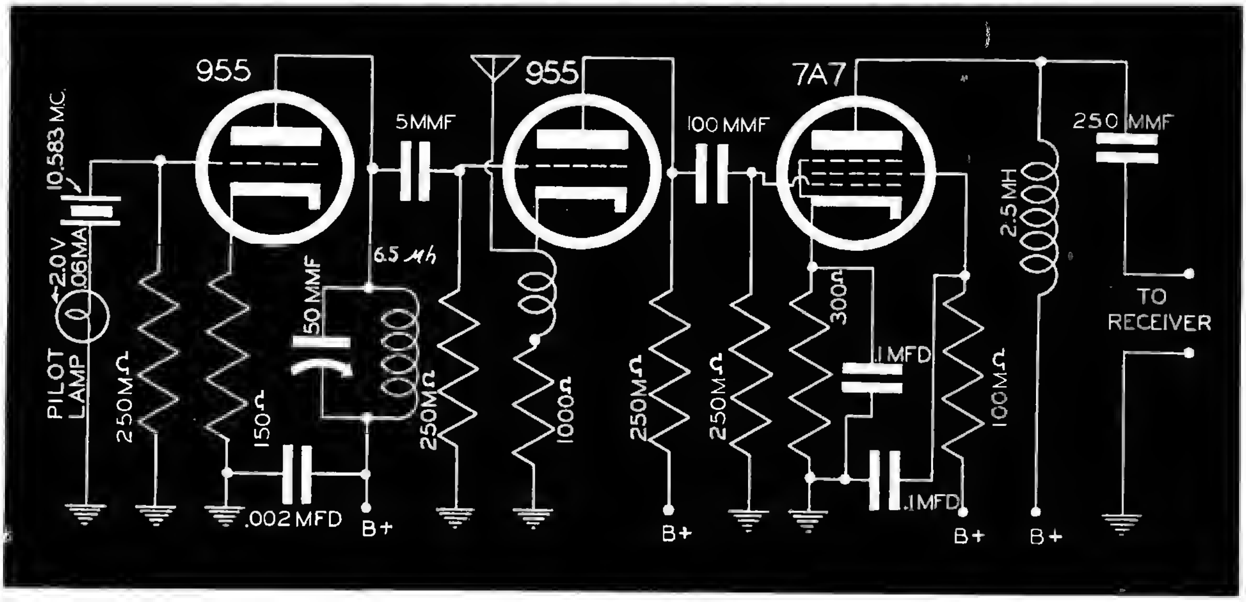


Figure 11
Frequency deviation mixer.

good indicator of how well the receiver is working is to pickup the re-radiation on any u-h-f receiver that employs an S meter. If in tuning through the super-regeneration, the S meter works smoothly to a peak and down again, the receiver will work well. If the S meter shows a number of peaks sharply accentuated, the s-r receiver will be very hard to tune and results will be poor for weak signals.

The above method can also be used to tune the s-r receiver accurately in the case of a fixed frequency. First the controlled frequency is picked up by the u-h-f receiver and the dial reading noted. Then the s-r receiver is adjusted until maximum deviation on the S meter is noted at the point where the controlled frequency was received. Some more pointers on the receiver will be discussed under the audio unit.

The Transmitter

The greater part of the story on the transmitter has been told in the development of the oscillator. Here again (see illustrations) the filaments have been effectively bypassed. This particular type of bypass brings the filament connections close to the source of power; the battery. The recommended grid resistor is 20,000 ohms. In actual practice, we use a 25,000 ohm resistor as a safety factor. A small r-f choke, 30 turns of 30 wire on a ¼" form is inserted in the plate lead to keep r-f out of the "B" supply. Inductive coupling is used to feed the antenna. As can be seen from the illustrations, the

(*Continued on page* 42)

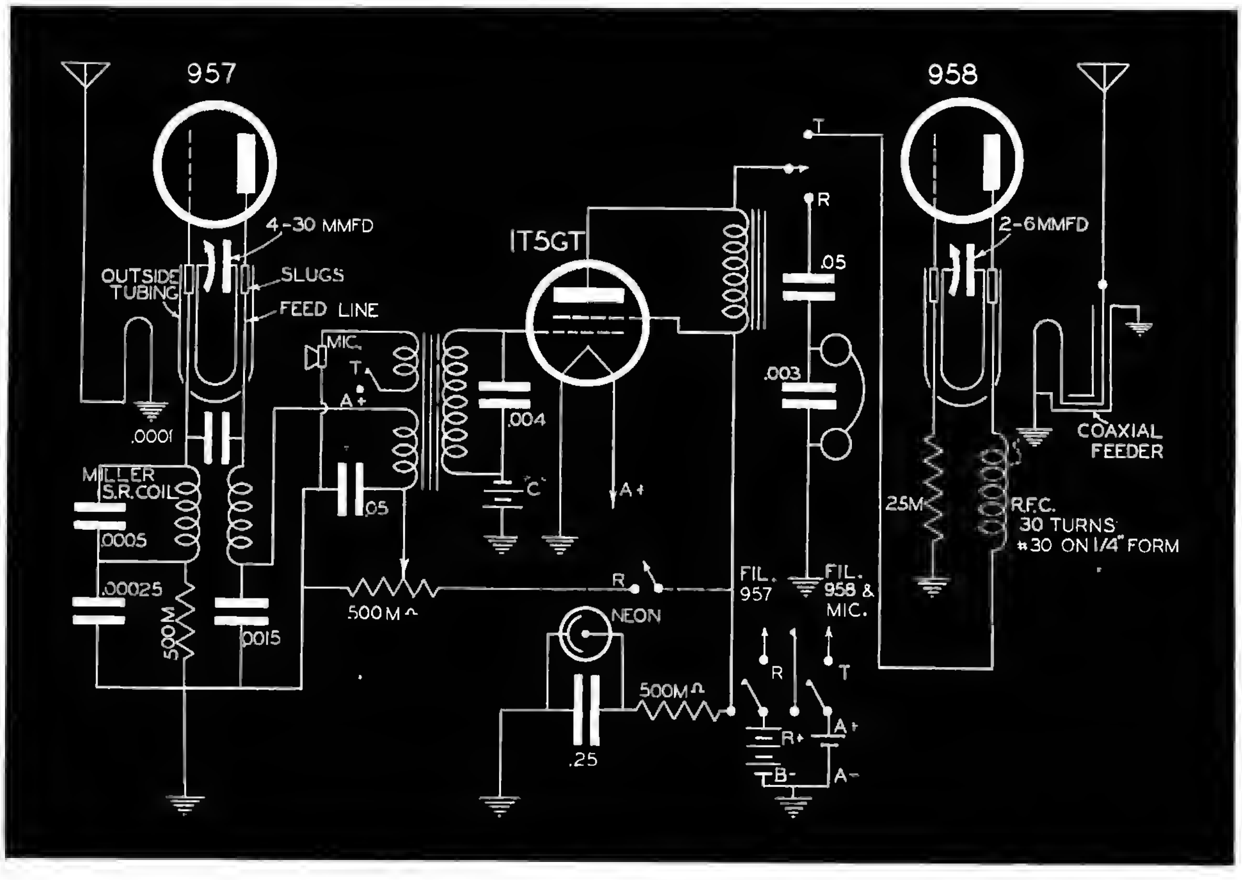


Figure 12
The complete pack set.

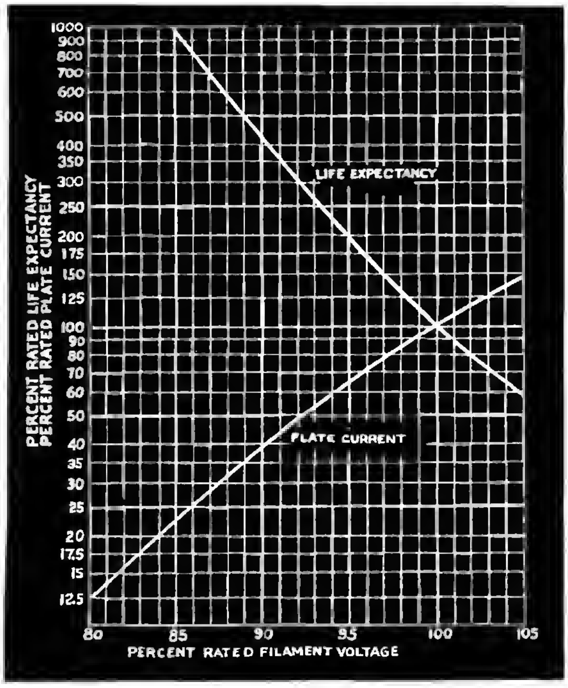


Figure 1
Life expectancy and plate current of a pure tungsten filament (calculated).

FILAMENT CONTROL AND ITS TUBE-LIFE AFFECT

by D. W. JENKS

General Electric Radio, Television and Electronics Department

THE useful life of electronic tubes is essentially the life of the cathode, for in normal operation failure of the cathode is the most common reason for tube failure. The most important factor in obtaining long cathode life is the use of proper filament voltage. Inasmuch as the ideal operating conditions differ with various types of cathodes, each type will be considered separately.

Pure Tungsten Filaments

Pure trungsten filaments are used in practically all high-power transmitting tubes. The life* of the filament is determined by the rate of evaporation of tungsten which in time reduces the diameter of the filament to such an extent that a hot spot develops and the filament "burns out." The design of tungsten filaments is always a compromise between long life and a reasonable emission efficiency; higher filament temperatures produce increased emission, but also cause greatly accelerated evaporation of tungsten and resultant decreased life. The theoretical variation of life expectancy and permissible plate current with filament voltage is shown in Figure 1. Several values taken from this curve are listed in Figure 4.

It is obvious from these data that small changes in filament voltage exert a tremendous effect on life and somewhat less effect on the available plate current. For example, a convenient figure to remember is that each five per cent reduction of filament voltage approvimately doubles the life expectancy while the available plate current is reduced about one-third. This immediately suggests the possibility of increasing tube life by lowering the filament voltage. Such a procedure is very desirable wherever the plate current demand does not exceed the amount available at the reduced filament voltage.

In order to secure the maximum obtainable filament life in any given application, three factors must be considered:

1)—*Minimum permissible filament voltage.*

2)—*Filament voltage fluctuation.*

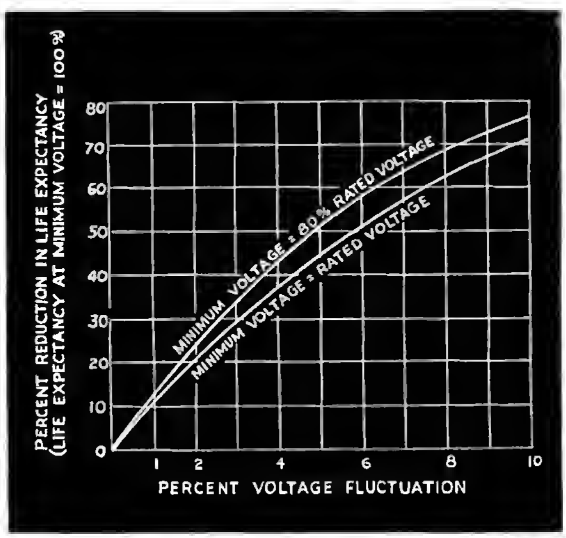
3)—*Filament voltage during standby.*

Each of these factors vitally affects tube life, and neglect of any one may easily offset the gain realized through proper adjustment of the other two.

The minimum permissible voltage is based solely on the available plate current supply at reduced voltage, as indicated in Figure 1. In order to secure minimum plate current demand, plate power should be reduced to the lowest possible value. In addition, it will often be found that by readjustment of the transmitter the required power output can be obtained at lower plate current, without exceeding distortion limits. A convenient method of determining the minimum filaments voltage is to operate the transmitter at normal filament voltage and adjust the plate current to a minimum. The filament voltage should then be reduced slowly until a barely perceptible reduction in power output or increase in distortion is noted. In general the voltage must be increased from this value in order to compensate for line voltage variations, but the value obtained is the *minimum permissible voltage* already mentioned. This voltage may be very near the rated filament voltage, but even a one per cent reduction in voltage, should not be dismissed as trivial. As an example, reference to Figure 1 reveals that reducing the voltage on a 10 volt filament only 0.1 volt to 9.9 volt makes possible almost two months additional service for each year of normal life.

Figure 2

From these curves we learn the reduction in life expectancy of pure tungsten filament that has been caused by a voltage increase to compensate for voltage fluctuation. It is thus apparent that automatic voltage regulation is an important factor in tube life control. These calculated curves were taken directly from those of Figure 1 by comparing the life at a particular filament voltage with the life at the higher voltage required to offset the voltage fluctuation.



*For further details on the design and characteristics of all types of cathodes see *Cathode Design*, by O. W. Pike, COMMUNICATIONS, Oct., 1941, pp. 5-8, 28.

Obviously the filament voltage must be set very accurately to secure maximum life.

In cases where the plate current requirements will not permit reducing the filament voltage, it is impossible to *increase* the life expectancy by this means. However, in order to secure the full *rated* life, it is essential that extreme care be exercised not to exceed the rated voltage at any time. Continuous operation at only one per cent overvoltage will reduce life more than ten per cent, a high price to pay for careless operation or inaccurate measurements.

It should be emphasized that tungsten filaments should always be operated at constant voltage rather than constant current, since this corresponds more closely to constant emission which, after all, is the desideratum. In direct contrast, operation at constant current results in gradually increasing temperature as the filament diameter is reduced by evaporation. This in turn produces an accelerated rate of evaporation with the net result that filament life is reduced to approximately one-third of that obtained at constant voltage. The recommended practice is to check the minimum permissible voltage as outlined above at least once a month. This will ensure adequate emission at all times yet will guard against reduced life caused by excessive voltage.

Once the minimum permissible operating voltage for a particular case has been determined, the problem of voltage fluctuation should be considered. Voltage fluctuation causes reduced life in two distinct ways, which unfortunately are compounded. First, if automatic voltage regulation is not available, the voltage must be continuously monitored, or the initial setting must be increased by an amount equivalent to the maximum voltage fluctuation encountered, so that the current limit is never exceeded when the line voltage drops. Figure 2 shows the reduction in life expectancy at various operating voltages caused by the voltage increase required to compensate for line voltage fluctuation. The curves shown were taken directly from Figure 1 by comparing the life at a particular filament voltage with the life at the higher voltage required to offset the voltage fluctuation.

The second way in which voltage fluctuation causes reduced life is less serious for small variations but becomes increasingly important as the fluctuation becomes greater. The loss in this case arises from the fact that available filament life is consumed at a rate which varies approximately exponentially with voltage rather than linearly. For example, if we assume the life curve in Figure 1 to be a straight line, the rate of life consumption at five per cent less than rated voltage is fifty per cent while the rate at five per cent above rated voltage is two hundred per cent. Therefore, if the filament were operated for equal time intervals at ninety-five per cent and one hundred five per cent of rated voltage, the mean rate of life consumption would be one hundred twenty-five per cent $\left(\frac{50 + 200}{2}\right)$ instead of one hundred per cent as it would be if the voltage were held exactly at its mean value. Thus the life expectancy is only eighty per cent, or a loss of twenty per cent caused by the five per cent fluctuation. Figure 3 shows the reduction in life at various operating voltages caused by the voltage fluctuation alone. The curves were calculated from the life curve of Figure 1 in the manner just outlined, assuming a square-wave voltage fluctuation, i.e. equal time intervals above and below the mean values. This assumption is of course not exact, since the voltage will surely not jump from its maximum to its minimum value and in addition it may be assumed to have its mean value at least part of the time. Therefore, the curves are somewhat pessimistic but conservative.

The effect of voltage fluctuation may then be summarized as follows. First, life is reduced because the voltage must be raised, and second, life is further reduced because the voltage fluctuates about this higher value. Figures 2 and 3 show that both effects are aggravated at the reduced filament voltages which are used to increase life. In other words, as filament voltage is reduced it becomes increasingly advantageous to minimize voltage fluctuation in order to secure maximum life. The final result is indicated by the curves of Figure 4 which show the life expectancy for various values of voltage fluctuation as a function of the minimum permissible filament voltage. It should be noted that the effects described by Figures 2 and 3 do not occur independently, but act simultaneously to produce the net results shown in Figure 4. Figure 5 shows the manner in which voltage fluctuation affects the available plate current and life when the voltage is adjusted to give rated life or rated current.

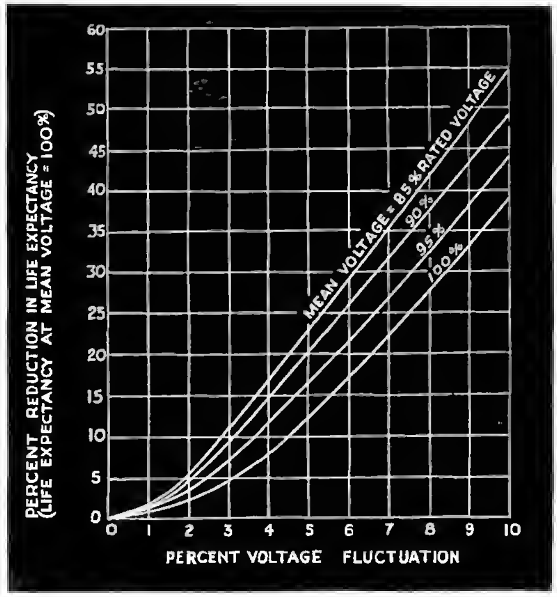


Figure 3

Reduction in life expectancy of pure tungsten filament caused by voltage fluctuation about various mean voltages calculated on basis of square wave fluctuation.

% Rated Filament Voltage	% Rated Life Expectancy	% Rated Plate Current
105	60	140
100	100	100
95	200	65
90	425	40
85	950	25

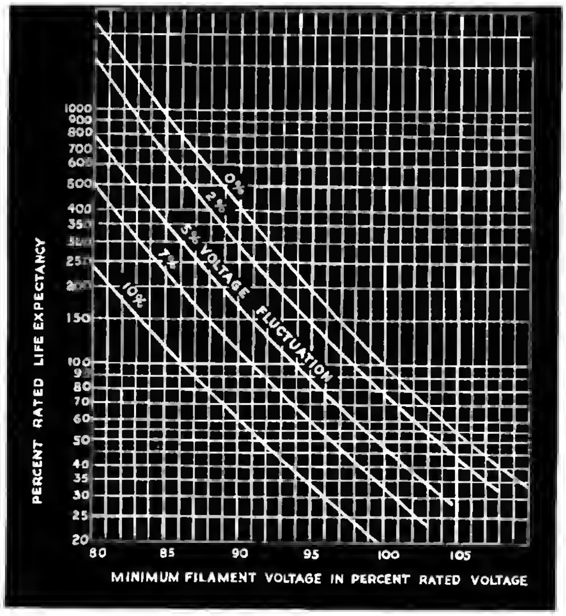
Figure 4

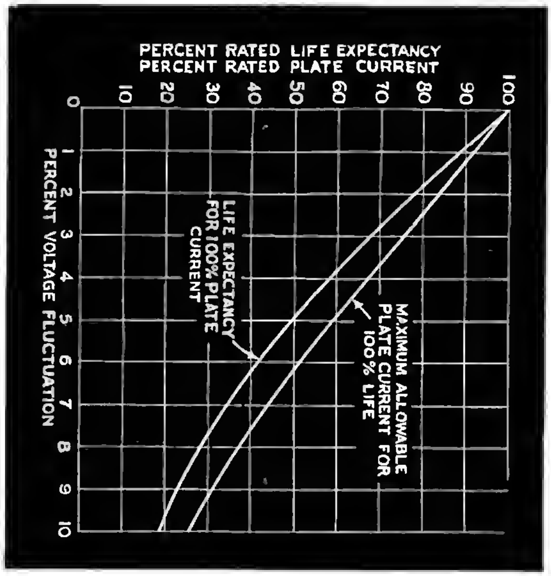
Several values of theoretical variations of life expectancy charted against permissible plate current and filament voltage.

As a final step in the effort to secure maximum filament life, strict attention should be paid to the manufacturer's recommendations on operation of the filament during standby periods. For pure tungsten filaments a voltage of eighty per cent of rated value is usually specified for standby periods up to two hours, with complete shutdown for longer periods. Again referring to Figure 1, it will be seen that at eighty per cent voltage the life is approximately 20 times the life at rated voltages, so that operation of the filament at this value does not materially effect the useful life of the tube. On the other hand if the filament is operated at full rated voltage during standby, available tube life is consumed just as rapidly as though plate voltage were applied. Thus if frequent periods of standby operation are required, means for reducing filament voltage will pay handsome dividends in increased life.

Thoriated-Tungsten Filaments

Operation of thoriated-tungsten filaments at reduced voltage in an effort to secure longer life cannot be recommended as a general rule. The explana-





Figs. 5 and 6

In Fig. 5 (extreme left) appears life expectancy data of a pure tungsten filament as a function of filament voltage and minimum permissible filament voltage. Fig. 6 shows the effect of voltage fluctuation on allowable plate current and life expectancy of pure tungsten filament. Both of these curves were calculated on a basis of square wave fluctuation.

tion of this fact is found in the nature of the thoriated-tungsten cathodes. The normal operating temperature is very much lower than for pure tungsten, so that thoriated-tungsten filaments seldom burn out unless defective. Failure of cathodes of this type is normally the result of exhaustion of the supply of thorium with resultant loss of emission. The operating temperature is, in this case, a compromise between stable emission and evaporation of thorium rather than tungsten. Too high a temperature results in excessive evaporation of thorium which has two harmful effects—first, reduced life because of rapid depletion of thorium supply, and second, the evaporated thorium may activate the grid and cause trouble from grid emission. Too low a temperature results in unstable emission because the rate of diffusion of thorium through the tungsten filament is greatly reduced, and may not be sufficient to keep the surface adequately covered with thorium. Operation under this condition usually causes permanent loss of emission.

Under normal conditions, a life of several thousand hours can be obtained from a thoriated-tungsten filament. If the tube is operated *well below ratings* it is *sometimes* possible to secure increased life by reducing filament voltage, but extreme care must be exercised not to exceed the cathode current available at the lower voltage. The safe operating plate current decreases much more rapidly than that for tungsten as shown in the curve in Figure 1, because of insufficient replenishment of the thorium layer at the reduced temperature. Emission-limited operation, which is most likely to occur where line voltage variations are excessive, is extremely dangerous. As mentioned previously, such operation usually causes damage to the filament and premature failure of the tube. It is always to assure ample emission even at minimum line voltage, than to gamble on operation at too low a voltage. This is simply because a thoriated filament usually fails more rapidly on insufficient voltage than it does at too high a voltage. It should be emphasized again that operation at *exactly the rated value* is usually the best practice to secure optimum life. In all cases it is well worth while to adjust and maintain the filament voltage very carefully.

Thoriated Filament Operation

Operation of thoriated filaments at eighty per cent of rated voltage during standby periods of less than two hours is usually recommended. This voltage does not materially affect the life of the filament and yet is sufficient to keep the cathode surface replenished with thorium, and makes emission more quickly available when the filament is raised to the normal operating temperature. If an emergency off-period is of only a few minutes duration, it is usually desirable to maintain the maximum voltage on the filaments of the tubes since the excessive cycles of heat-

(*Continued on page* 44)

Type of Cathode	***Performance on Reduced Voltage****	***Performance on Over-Voltage***
Tungsten	Increased life. Should be used whenever possible. Filament not likely to be damaged by emission-limited operation.	Reduced life. Should never be used.
Thoriated-tungsten	Not generally recommended. May increase life if operation is well below rating.** Filament may be ruined in short time by emission-limited operation.	Reduced life. Tendency to cause grid emission. Should only be used to compensate for bad line-voltage fluctuations.
Oxide-coated in high-vacuum tubes	Not generally recommended. Very satisfactory if tube is operated well below ratings.**	Reduced life. Serious danger of causing grid emission. Should be used only to compensate for bad line voltage fluctuations.
Oxide-coated in gaseous tubes	Not recommended. Reduced life. Cathode may be ruined in short time because of excessive arc drop.	Reduced life. Danger of causing grid emission or arc-backs. Should be used only to compensate for bad line voltage fluctuations.

*On all types of cathodes, available cathode current is reduced. Plate current should not exceed this value. Effects of line voltage fluctuation are aggravated.

**Manufacturer's recommendations for particular application should be secured before operation at reduced voltage is attempted.

Figure 7
Filament voltage variation guide.

High Frequency

RESPONSE OF VIDEO AMPLIFIERS*

by ALBERT PREISMAN

Development Engineer, Federal Telegraph and Radio Corp.

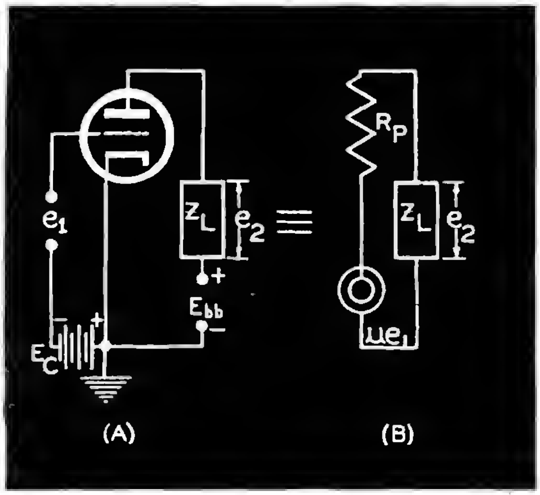


Figure 1
The fundamental action of a voltage amplifier stage is illustrated here.

A VIDEO amplifier is generally considered to be one whose frequency range spans a greater number of octaves than an audio amplifier, and extends to frequencies far beyond the audio range. As an example, a typical video amplifier may amplify voltages of frequencies extending from 30 up to 5 million cycles per second. An additional requirement for a satisfactory video amplifier is that the phase shift be as nearly linear with frequency as possible, or, in other words, that the variations in time delay be within a fraction of a microsecond. The later phase requirement is something that is normally not stipulated for an audio amplifier. In a previous article[1] the writer discussed the requirements for good low frequency response. In this paper, high frequency response characteristics are analyzed.

Voltage Amplifier Analysis

Before proceeding with the more specific analysis of the video amplifier it may be well to review briefly the fundamental action of a voltage amplifier stage. Such a circuit is shown in Figure 1A. By the equivalent plate circuit theorem, the actual circuit may be represented by an equivalent circuit, shown in Figure 1B, which is more suitable for the purpose of analysis. In either circuit Z_L refers to a load impedance across which the output voltage e_2 is to be developed for a given input voltage e_1, which appears as μe_1, an apparent generated voltage in the plate circuit, of which the internal plate resistance is denoted by R_p. The output voltage is equal to the generated voltage multiplied by the ratio of the external load impedance to the total impedance of the plate circuit, that is

$$e_2 = e_1 \mu \left(\frac{Z_L}{R_p + Z_L} \right) \quad (1)$$

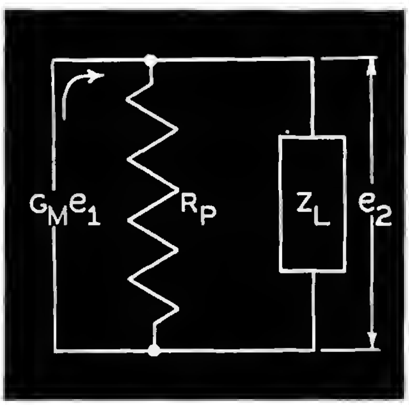
from which the circuit gain is evidently

$$\alpha = \frac{E_1}{E_2} = \mu \left(\frac{Z_L}{R_p + Z_L} \right) \quad (2)$$

We note from Eq. (2) that while μ is a real number, the fraction following it is a complex number, so that α is consequently a complex number. This indicates not only the magnitude of e_2 compared to e_1 but the phase angle between them at any frequency, i.e., the phase shift through the amplifier stage. If we multiply numerator and denom-

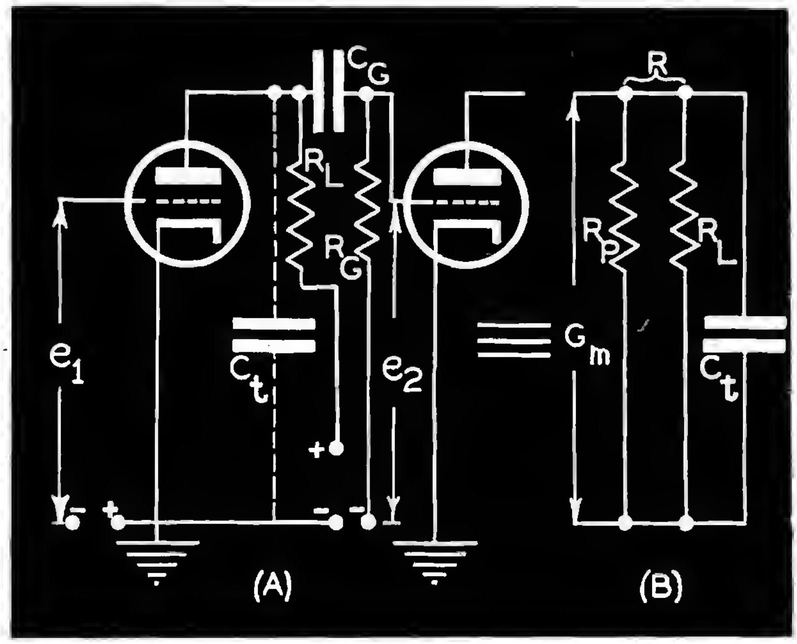
(*Continued on page 19*)

This paper, specially prepared for COMMUNICATIONS, is based on a talk presented by the author before the Communications group of the New York AIEE on October 26 on Video Amplifiers.

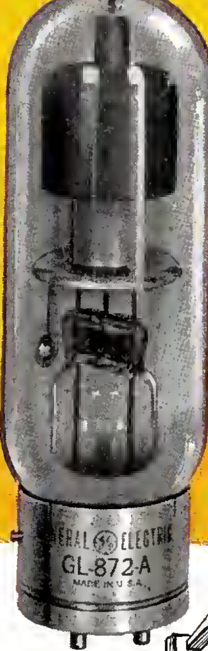


Figures 2 and 3

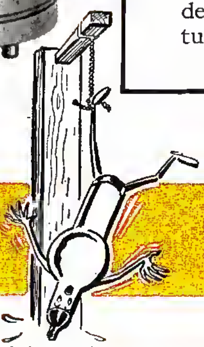
Figure 2 (left), a constant current circuit wherein the current $G_m E_I$ generated, flows into the plate resistance R_p of the actual tube and the external load impedance Z_L in parallel. Figure 3 (right), a constant current circuit equivalent to the constant (generated) voltage circuit shown in Figure 1 (B).



How to Get Longer Life from *Your* MERCURY-VAPOR TUBES



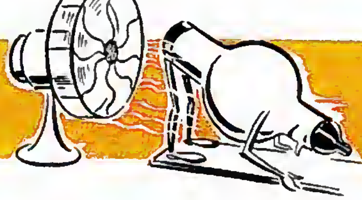
Here's a four-word formula to make your mercury-vapor tubes last longer—"Handle carefully; operate conservatively." Below are a few suggestions to help you put this formula into effect. They will help prevent many of the causes of tube failure, such as: loss of emission, high arc-drop, cathode bombardment, arc-backs, the liberation of gas, and cathode failure. These safeguards are applicable to such tubes as the following General Electric mercury-vapor rectifiers: GL-266B, GL-857B, GL-866A/866, GL-869B, GL-872, GL-872A. For more complete instructions on operation and handling, write for Bulletin GEH-977B. Also list the types of G-E mercury-vapor rectifiers you are now using. We shall be glad to send you complete service information designed to help you get the most out of your mercury-vapor tubes. *General Electric, Schenectady, N. Y.*



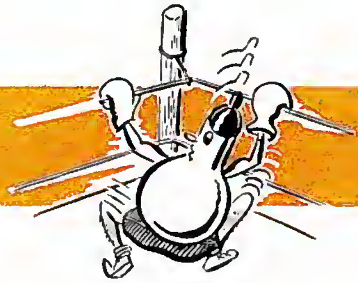
1
Keep tubes upright and avoid splashing mercury around. When tubes are first placed in operation, be sure to apply cathode voltage *alone* until mercury is properly distributed.

2
Keep condensed mercury temperature within limits recommended by tube manufacturer.

3
Be sure cathode base, not the anode end, is coolest part of tube. Don't let drafts blow on tubes. Never allow the mercury to condense at the anode end.

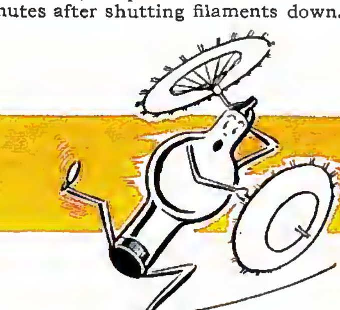


4
If you use forced air against the bottom of the tube, keep the blower on for a few minutes after shutting filaments down.



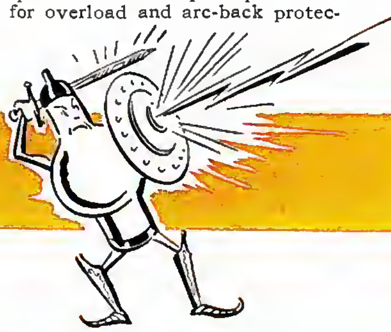
5
Allow plenty of filament warm-up time before applying anode voltage.

6
Keep peak inverse anode voltage and peak current as low as possible for satisfactory operation. Use adequate protective devices for overload and arc-back protection.



7
Do not allow the cathode voltage (measured at the pins) to deviate more than five per cent from the rated value.

8
Don't overload tubes, even for short periods. Maintain full cathode voltage during standby operation when tube is operated without load.



9
Protect the tubes adequately against the effects of r-f.

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VIDEO HIGH FREQUENCY RESPONSE

(*Continued from page* 16)

inator of Eq. (2) by R_p we obtain

$$\alpha = (\mu/R_p)\left(\frac{R_p Z_L}{R_p + Z_L}\right)$$

$$= G_m\left(\frac{R_p Z_L}{R_p + Z_L}\right) \qquad (3)$$

Eq. (3) may be interpreted as representing the behavior of a circuit shown in Figure 2. This circuit shows a constant current generator generating a current $G_m e_1$ which flows into the plate resistance R_p of the actual tube and the external load impedance Z_L in parallel. A constant current generator may be conceived as one whose internal impedance and generated voltage are indefinitely large, so that the ratio, however, of the generated voltage to the internal impedance is a finite quantity here represented by $G_m e_1$. This ratio represents the short circuit current that would flow in such a generator. Evidently the current will not be appreciably reduced if a finite external load impedance is inserted in series with the generator terminals.

The circuit of Figure 3 is known as the constant current circuit equivalent to the constant (generated) voltage circuit shown in Figure 1B. This equivalence is obviously true for any linear circuit and holds for a vacuum tube circuit when the latter is operated over its substantially linear range.

Eq. (3) is particularly useful for the analysis of video amplifiers and will be employed in the remainder of this article. In the special case where high resistance tubes such as pentodes are used so that R_p is much greater than Z_L, Eq. (3) becomes particularly simple, namely,

$$\alpha = G_m Z_L \qquad (4)$$

Since G_m is independent of frequency, it is evident from Eq. (4) that the performance of a voltage amplifier stage (particularly in the case of a pentode tube) depends upon the behavior of Z_L with frequency. The variations in magnitude of Z_L with frequency represent the variations in gain of the amplifier stage; the variations in phase angle of Z_L with frequency represent the variations in phase shift through the amplifier with frequency. These remarks apply particularly to a two terminal network employed as a load impedance, that is, one in which the output voltage to the next grid is essentially picked off the terminals of Z_L to which the plate and cathode of the previous tube are connected. Particularly in the case of a video amplifier, it is desirable that

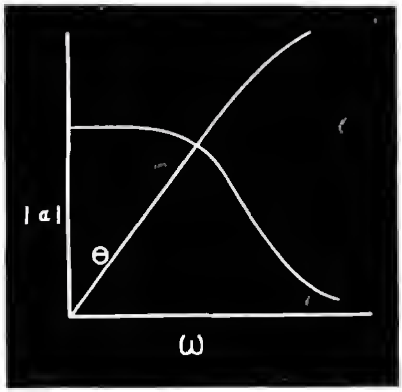

Figure 4
Two components of gain plotted independently.

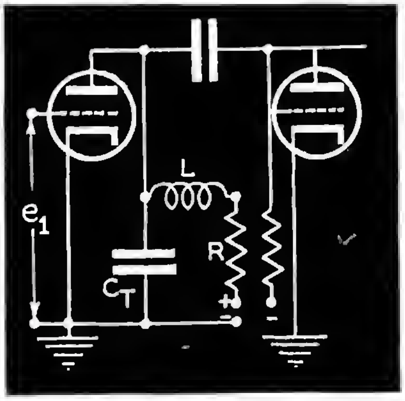

Figure 5
A simple modification of the resistance coupled stage shown in Figure 3(A).

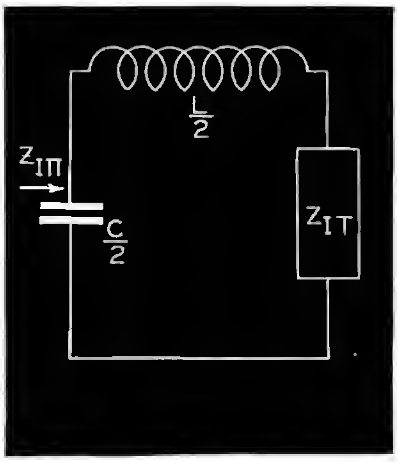

Figure 6
Due to the asymmetry of the half section, it has a different image impedance when viewed from either pair of terminals.

Z_L maintain a constant amplitude over the frequency range desired and then falls off gradually while the phase angle of Z_L increases proportionately with frequency in such manner that its graph against frequency passes through the origin and has a positive slope.

We shall next proceed to consider various forms of Z_L which at least partially meet the above requirements.

Resistance Coupled Amplifier

The most elementary type of video amplifier circuit and one that is commonly employed in audio amplifiers is shown in Figure 3A. R_L represents the external load impedance (in this case a resistance) and C_t represents the capacity associated with the two tubes involved. Part of it is the plate-to-cathode interelectrode capacitance of the first tube. A second part represents the input capacitance of the second tube and the remainder represents the stray wiring capacity normally associated with the actual circuit. Usual values in practice are between 25 and 30 mmf. The parameters C_g and R_g represent the coupling network to the next grid. At the higher frequencies considered here, C_g is practically a short circuit and R_g is a very high shunt resistance to R_I and C_t; and hence they can be neglected in the further discussion of the circuit. The equivalent circuit is shown in Figure 3B and it will be noted that R_p and R_L can be combined into an equivalent resistance R which is further in parallel with C_t. The combination represents the Z_L of Eq. (3) so that the gain after some algebraic simplification becomes

$$\alpha = \frac{G_m R}{1 + j\omega C_t R} = \frac{G_m R \,\underline{/-\tan^{-1}\omega C_t R}}{\sqrt{1 + \omega^2 C_t^2 R^2}} = |\alpha|(\omega)\,\underline{/\theta(\omega)} \qquad (5)$$

The first form is in complex notation, Eq. (5), and the second in the equivalent trigonometric notation, namely, an amplitude at an angle (given by its arctangent), while the third form expresses more generally the fact that the gain may be represented by a magnitude which is a function of the angular frequency ω, at an angle which is also a function of ω. The two components of the gain are plotted independently in Figure 4. It is evident that the amplitude of the gain drops off with increase in ω and approaches zero asymptotically while the phase shift is not linear with frequency except approximately for a short distance from zero frequency. Reference to Eq. (5) indicates that if we wish this amplifier to be approximately flat to a high value of ω it is necessary that $C_t R$ be correspondingly small in order that the product $\omega^2 C_t^2 R^2$ be small compared to unity. For a given value of C_t determined by the shape of tube and circuit layout, such flatness of gain and also linearity of phase shift can be achieved only by the use of a small load resistance R_L, which in turn means that the magnitude of the gain will be small. Thus, so-called video amplifiers that are to be flat to 100,000 cycles or more, often

(*Continued on page* 20)

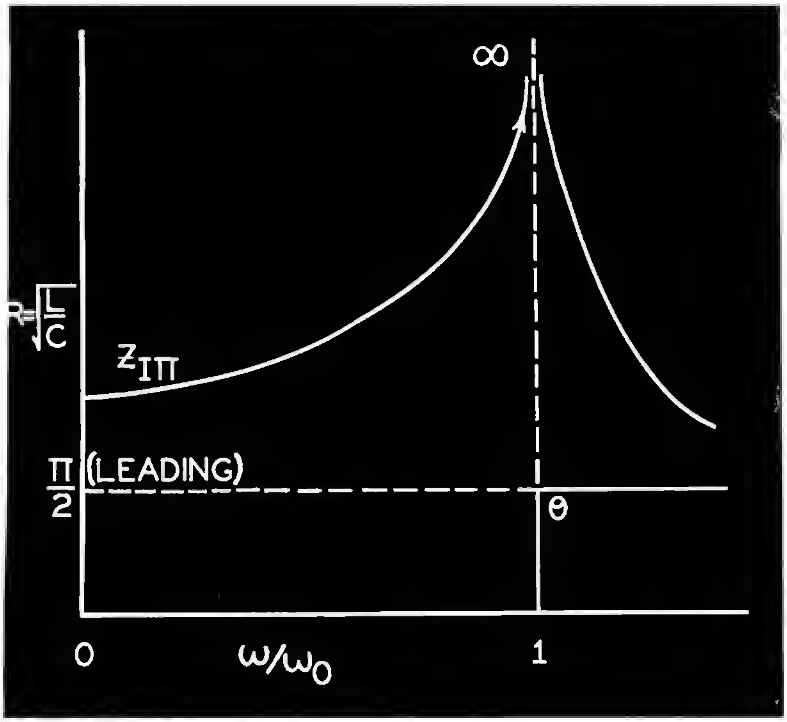

Figure 7

Since either image impedance may be found by taking the square root of the product of the open circuit and short circuit measurements or calculations made from a corresponding pair of terminals, a curve as shown here may be plotted, with the impedance plotted against the frequency ratio.

employ load resistances of but a few thousand ohms. If a high G_m tube is employed, however, reasonable values of gain may be obtained of the order of twenty or more.

Use of Filter Theory

In order to maintain a high value for Z_L over as wide a frequency range as possible consistent with linearity of phase shift, various more complicated circuits are employed. A very useful method of deriving a suitable circuit configuration is based on filter theory. In Figure 5 is shown a simple modification of the resistance coupling stage shown in Figure 3A, namely, the introduction of an inductance L in series with the load resistance here denoted by R. We may regard the circuit as a parallel resonant LC_t circuit sufficiently damped by R to maintain a relatively constant impedance over a wide band of frequencies. However, the circuit is purposely drawn in such manner as to suggest that it represents a half section constant k filter terminated in what can be its nominal image impedance. Accordingly, it will be of interest to study the behavior of such a filter section when terminated in its true image impedance and viewed from its mid shunt terminals. (Figure 6).

We note in passing that a half section due to its asymmetry has a different image impedance when viewed from either pair of terminals. Thus (Figure 6) on the left hand side it has the image impedance of a π section, whereas, on the right hand side it has the image impedance of a T section. Either image impedance may be found by taking the square root of the product of the open circuit and short circuit measurements or calculations made from the corresponding pair of terminals. If this be done, it will be found that

$$Z_{I\pi} = \frac{\sqrt{L/C}}{\sqrt{1-(\omega/\omega_0)^2}}$$

where

$$\omega_0 = 2/\sqrt{LC} \tag{6}$$

If $Z_{I\pi}$ be plotted against the frequency ratio (ω/ω_0), the plot will be as in Figure 7. As ω/ω_0 approaches unity, the denominator of Eq. (6) approaches zero and consequently $Z_{I\pi}$ approaches infinity. For values of ω/ω_0 greater than unity $Z_{I\pi}$ becomes a pure capacitive reactance and decreases asymptotically to zero. The interesting feature is that for values of ω/ω_0 less than unity $Z_{I\pi}$ is a pure resistance, which, however, is a function of frequency. Such an impedance is not physically realizable and arises in this example because of the assumption that this half section is terminated at its right hand end (Figure 6) in the true image impedance of a T section. The latter image impedance is not physically realizable since one suggested form for it is an infinite succession of T sections in cascade. However, were such a termination physically available it would not be of any use as shown since the gain (which would be simply $G_m Z_{I\pi}$) would rise to infinity (in the case of a true constant current generator) as ω/ω_0 approached unity. In practice, the gain would rise to a peak instead of being flat over a band of frequencies and then falling off gradually. It is therefore evident that a constant k half section filter is not in itself desirable unless suitably modified. A general method of modification is due to Percival[2] and is given in the next section of this paper below.

Method Due to Percival

If we parallel the image impedance Z_I with another impedance which decreases as the frequency increases, we may expect to obtain a total impedance which possibly may be constant up to cut-off frequency and then decreases. The form of the parallel impedance that obviously suggests itself is that of a condenser. To facilitate the formulation of the parallel impedance, we first note that from Eq. (6) we may express $Z_{I\pi}$ as having a value at zero frequency of

$$R_0 = \sqrt{L/C} = \frac{2}{\omega_0 C}$$

or

$$C = \frac{2}{\omega_0 R_0} \tag{7}$$

The additional shunt condenser may be expressed as

$$Cn = \frac{n}{\omega_0 R_0} \tag{8}$$

where n is some as yet undetermined constant. (See Figure 8.) The joint impedance Z is then evidently equal to the reciprocal of the sum of the two admittances involved or

$$Z = \frac{1}{\dfrac{jn(\omega/\omega_0)}{R_0} + \dfrac{\sqrt{1-(\omega/\omega_0)^2}}{R_0}} = \frac{R_0}{\sqrt{1-(\omega/\omega_0)^2\,(n^2-1)}} \Bigg/ -\tan^{-1}\frac{n\,(\omega/\omega_0)}{\sqrt{1-(\omega/\omega_0)^2}} \tag{9}$$

If n = 1, Equation (9) reduces to

$$Z = R_0 \,/\!-\sin^{-1}(\omega/\omega_0) \tag{10}$$

from which it is evident that the magnitude of Z_0 is now independent of the frequency ratio ω/ω_0 up to the cut-off fre-

(*Continued on page* 38)

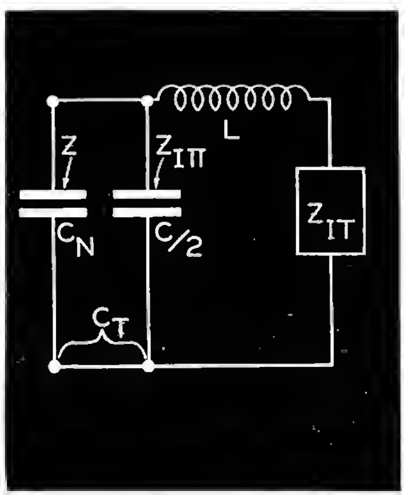

Figure 8

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UNITED ELECTRONICS COMPANY

NEWARK, NEW JERSEY

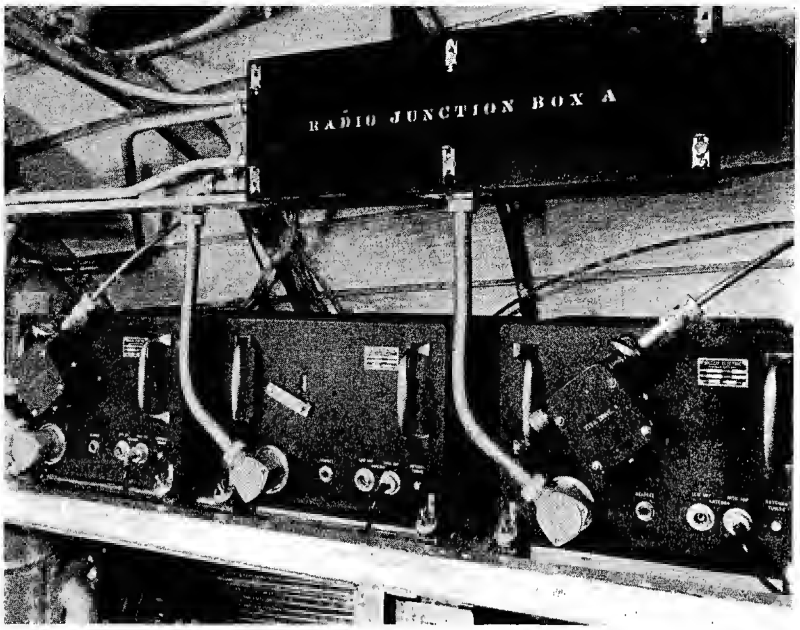


Figure 1

A typical receiver installation aboard a plane. Inter-connection of the receiver cables with their associated external circuits are made on the terminal strips located in the radio junction box. The receivers are secured in apparatus mounts by wing-nut arrangements that engage the panel clip. To preclude cable wiring breaking the flexible conduits are of such length that cable strain does not exist. This permits full travel of rubber shock mounts. The flexible shaft is sufficiently long to permit a curve entrance. This practice is essential to prevent transmittal of aircraft structure vibration.

Receiver Design Factors In

AIRCRAFT COMMUNICATIONS

by CHARLES W. McKEE

Supervisor of Aircraft Radio, Eastern Air Lines, Inc.

In the design of aircraft radio beacon receivers, there are certain factors to be considered that are not generally encountered in conventional receiver design. These requirements are obviously of an exacting nature because of their important role in aircraft navigation. It is of utmost importance that consideration be given to a design that is inherently free of trouble. Its construction must be rugged; performance reliable, and, in addition, minimum maintenance must be assured. Another concerning factor is that of component placement. They must be readily accessible for periodic inspection.

To determine these design factors it has been found prudent to prepare charts. An analysis of receivers used over a period of several years service thus becomes essential. During this period a record must be kept of all repairs and irregularities of a large number of units. These data are then classified and tabulated. In this way it is possible to eliminate guess-work as to the selection of the proper circuit and components.

Additional data included in this study covers performance, service requirements, maintenance technique, operating conditions, etc. Employing this analysis-guide-study of design, two effective receivers, known as the S-101 and S-102, were developed.

To appreciate the design features that had to be included, the interesting uses of these receivers will be discussed first. Aboard aircraft a dual beacon receiver installation is mandatory so that cross checks may be made on two-range directional legs. This can normally be done simultaneously with a dual installation. In rare instances, should one unit fail, a safety factor is provided when two receivers are used. To supplement the aircraft high frequency communication receiver a low-frequency (S-102) receiver is used for a reception channel to cover the airport control tower transmission. At present the use of low frequencies predominates in this type of service. However, it is planned and tests are now being made for the use of u-h-f. In the past one of the beacon receivers was used to cover the control tower i-f channel. Now, a separate receiver is highly desirable, so that two beacon receivers are provided solely for the purpose of radio beacon reception. This arrangement permits the pilots to monitor range signals from two stations and maintain constant contact with the control tower during the approach to the airport and during the time that adverse weather conditions exist.

S-101 Receiver

This receiver* employs a superheterodyne circuit, designed especially for radio beacon reception. The receiver is housed in a rugged case of which the overall dimensions are 7⅜" high, 10⅜"

*See October, 1942, COMMUNICATIONS.

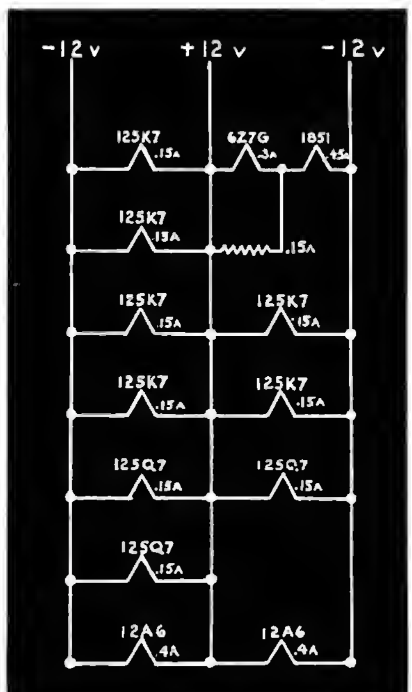


Figure 2
Heater circuit arrangement of tubes in S-102 receiver that consists of three units . . . a 278 kc receiver, 362 kc receiver and an ultra-high-frequency receiver.

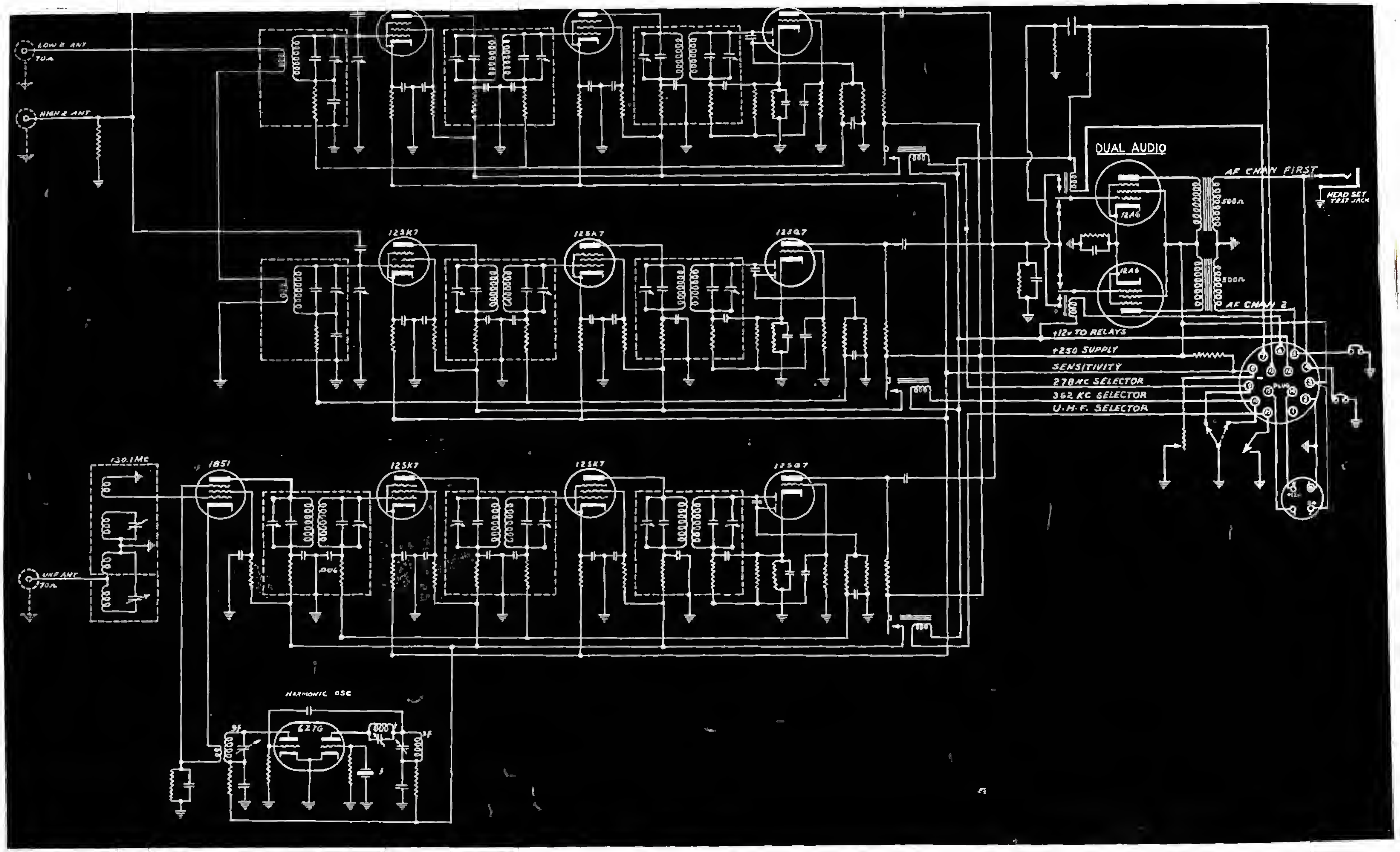


Figure 3

The three-channel receiver, known as type S-102. Top is the 278 kc channel unit. Center is the 362 kc channel receiver, and at bottom is the ultra-high-frequency channel unit. The heater circuit arrangements for the tubes in this unit are diagrammed in Figure 2.

NEWS BRIEFS OF THE MONTH . . .

I.T.&T. AERO LANDING SYSTEM DEDICATED

Officials of the Civil Aeronautics Administration and of the International Telephone and Telegraph Corporation dedicated the airplane radio instrument landing system at the La Guardia Field recently with a flight demonstration.

Mayor Fiorello LaGuardia, CAA executives, Colonel Sosthenes Behn, president of I. T. & T. were among those present at the demonstration.

The system was developed jointly by the CAA engineers and the engineers of Federal Telephone and Radio Corporation.

Use of the system by the air transport lines makes landings possible at weather ceilings considerably below the safety margins permitted at present without relaxing safety.

* * *

STANCOR AWARDS VETERANS

At a banquet and celebration, held recently at the Standard Club, Chicago, Standard Transformer Corporation acted as host to 105 of its employees who served the corporation for five years or more. The event inaugurated the presentation of honor awards. These were silver emblems for those who had served five to nine years, and gold emblems for those who had served the company continuously for ten years or more.

Guest speakers included Lt. Col. Boruszak, Lt. Com. George C. Norwood, Major H. E. Billington, Major Eldon A. Koerner, Major Leo E. Steiner, Jerome J. Kahn, Stancor president, and Levi Anderson. Kenneth C. Prince served as toastmaster.

* * *

GHIRARDI BOOK DISPLAY

A counter and widow card publicizing Ghiraldi books is being offered free to radio jobbers by the Radio & Technical Publishing Co., 45 Astor Place, New York, N. Y. The entire display is made of heavy, die-cut cardboard in five striking oil colors.

A pair of these new displays, one for the window and one for the counter, are available to jobbers free of charge by addressing the publisher direct.

* * *

HALLICRAFTERS PUBLISHES "E" AWARD BROCHURE

An attractive brochure commemorating the presentation of the "E" award, has been prepared by the Hallicrafters Company, Chicago, Ill.

Many pages of illustrations depicting the award ceremonies are presented in this booklet, in addition to a complete report of the activities that took place.

* * *

HAZELTINE MOVES OFFICES

The executive offices of the Hazeltine Service Corporation have been moved to 1775 Broadway, New York City. The New York laboratory remains at 333 West 52nd Street, New York City.

* * *

W. A. AMSLER ELECTED TO CIA

William A. Amsler, controller and assistant treasurer of the Wincharger Corporation, Sioux City, Iowa, has been elected to membership in the Controllers Institute of America, a technical and professional organization of controllers devoted to improvement of controllership procedure.

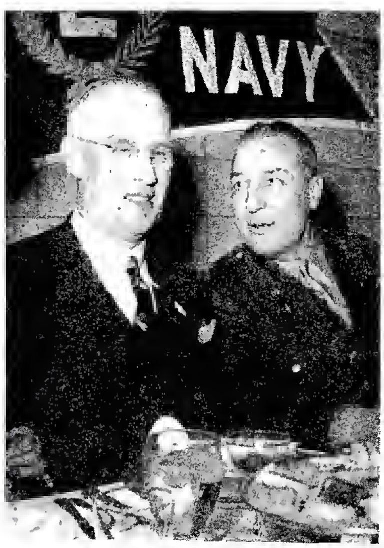
BUTLER WINS WPB AWARD

Madison Butler, assistant chief inspector of the Stromberg-Carlson Tel. Mfg. Co., has been awarded the highest honor within the power of War Production Board, the "Citation of Individual Production Merit." Presentation of the award was made by President Roosevelt, at the White House.

Mr. Butler won the award for a suggestion and design of a testing device for communications instruments that has had startling results. It cut the testing time required for one instrument from an average of 80 man-hours to one man-hour. On a single order, according to company officials, 86,900 man-hours were saved. Butler's device has another highly important advantage. Formerly it was necessary to test such instruments with men who were virtually engineers. Through the use of Butler's device, the tester need only be a person of average intelligence with a short period of training, for the device has virtually eliminated the factor of human error. The Signal Corps uses women to operate the device.

* * *

AT THE CLAROSTAT "E" AWARD



John J. Mucher, president of Clarostat Mfg. Co., Inc., and Major H. R. Battley, Regional Public Relations Officer of the U. S. Army Air Force, at the banquet following the awarding of the Army-Navy "E" for excellence in war production

D. W. MAY WINS G. E. PROMOTION

D. W. May, formerly sales manager of the metropolitan distributing branch of G. E., has been named eastern regional manager of the receiver division of G. E. In his new assignment, Mr. May will direct the sale of G. E. radio receivers and renewal tubes.

* * *

DAVID S. YOUNGHOLM DIES

David S. Youngholm, vice-president of the Westinghouse Electric & Manufacturing Company, in charge of the Lamp Division, Bloomfield, N. J., died recently from a sudden heart attack.

* * *

EICOR EXPANDS

Eicor, Inc., manufacturers of dynamotors, d-c motors, converters, power plants, and other rotary electrical apparatus, are moving to a new DPC building at 1501 W. Congress Street, corner of Congress and Laflin, Chicago, Ill.

* * *

PLASTICS REPLACING STEEL

Plastics composition which can replace steel or other metals in many uses, may now be manufactured by incorporating with various cellulosic fibers a resin powder known as Vinsol, extracted by Hercules Powder Company chemists, from the Southern pine tree, according to The Patent and Licensing Corporation, New York.

This new structural resin is a thermoplastic, fibrous-resin composition; hard, dense, stiff but with reasonable toughness. It is described as sturdy but lightweight, and has low water absorption. One of its best characteristics is its high resistance to petroleum products.

The Vinsol resin is currently available without priorities.

* * *

NEW NATIONAL UNION PLANT OPENS

The new plant of the National Union Radio Corporation at Lansdale, Pa., was formally opened recently.

* * *

WESTINGHOUSE PROMOTES BATE AND SUITER

G. V. Bate has been appointed superintendent and L. E. G. Suiter as supervisor of production, at the Sunbury Works of the Westinghouse Electric & Manufacturing Company.

* * *

NEW RCA ELECTRON MICROSCOPE

A new electron microscope, small enough and inexpensive enough to make it available to hund eds of medical, university, and industrial research institutions has been developed by RCA Laboratories according to Dr. V. K. Zworykin, associate director of the laboratories. It is only 16 inches long and light enough to be portable. It is capable of magnifying infinitesimally small particles of matter up to 100,000 times. In this respect it equals in performance the standard size instrument, introduced by RCA two years ago.

* * *

UNITED ELECTRONICS WORKERS CONGRATULATED BY GOVERNOR

Workers at the United Electronics Company, 42 Spring Street, Newark, have been congratulated on their war effort in an open

letter from Governor Charles A. Edison.

The Governor hailed "Top the Top," the slogan of United's production campaign, as it "expresses the determination of every worker to produce more and more of the transmission tubes to the Army and Navy and the Lend-Lease program of aid to our allies."

This is the second letter from a high government official that United Electronics has received within a month praising the "Top the Top" campaign. Early last month Donald M. Nelson paid tribute to the company's war production drive and urged even greater efforts.

The "Top the Top" campaign is being handled by the company's War Production Drive Committee. Charles A. Rice is chairman.

* * *

AIRCRAFT-MARINE CATALOG

A 36 page catalog replete with data on solderless wiring devices, has just been released by Aircraft-Marine Products, Inc., 286 North Broad St., Elizabeth, N. J.

Blueprint diagrams of hundreds of types of solderless units appear together with design and application data, that will be most helpful to engineers and purchasing agents. Also described are the AMP crimping tools that provide three crimps at one time.

Copies of the catalog are available upon letterhead request.

* * *

CELANESE CELLULOID ISSUES PLASTICS BOOK

An unusually comprehensive book on "Cellulose Plastics In War and Industry" has been published by the Celanese Celluloid Corporation, 180, Madison Ave., New York, N. Y.

In its 68 pages will be found invaluable specification, property and application data on cellulose plastics from rods, sheets and tubes, to cements. It is truly a welcome addition to the technical library. And copies are free for the asking. Send your request in on your letterhead.

* * *

RADIO CITY APPOINTS PRIORITIES SPECIALIST

Irving Berkman has been appointed manager of priorities and expediting for the Radio City Products Co., Inc., 127 West 26th Street, New York City.

* * *

DR. POWER CELEBRATES 20TH YEAR IN RADIO

Dr. Ralph L. Power, former advertising manager of the Universal Microphone Co., Inglewood, Cal., has just celebrated his 20th year in radio and, at the same time, was notified of his election to the Companion grade by the Council of the Australian Institution of Radio Engineers.

Dr. Power served overseas as a warrant officer in World War 1, and is now an inspector in the U. S. Army Signal Corps with assignment to a field unit in the west.

After ten years of daily newspaper radio editing, and station management in Los Angeles, Dr. Power in 1932 opened his own office. He had previously been professor of business administration at the University of Southern California.

* * *

STANCOR ISSUES NEW CATALOG

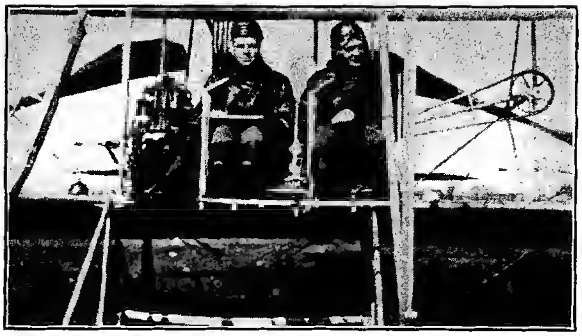
A professional series of transformers are described in the latest 16-page catalog of the Standard Transformer Corporation, Chicago, Ill.

Among the transformers illustrated and

(*Continued on page* 49)

VETERAN WIRELESS OPERATORS ASSOCIATION NEWS

W. J. McGONIGLE, President — RCA BUILDING, 30 Rockefeller Plaza, New York, N. Y. — GEORGE H. CLARK, Secretary



Left to right: Lieut. Follett Bradley, observer and radio operator, and Lieut. Henry H. Arnold, pilot, in world's first successful radio air-to-ground test at Ft. Riley, Kansas — November 2, 1912.

(*Official photograph U. S. Army Air Corps.*)

Nominations

At the November meeting of our Association at which a quorum of directors was present, the following members were nominated for the various offices and the Board of Directors, (all the officers were unanimously nominated to appear on the ballot unopposed). They are: William J. McGonigle, New York Telephone Company, for a seventh term as president; A. J. Costigan, Radiomarine Corporation of America, for a fifth term as vice-president; George H. Clark, Radio Corporation of America, formerly a vice-president, then president and for the past several years a most efficient secretary, again nominated to succeed himself in the latter office; William C. Simon, Tropical Radio Telegraph Company, such a good treasurer that he will probably become our permanent Chancellor of the Exchequer. . . at least he has agreed to serve during 1943.

Twenty members were nominated for the office of director. All of their names will appear on the ballot mailed to the membership. The eight receiving the highest number of votes will assume office as the new Board of Directors for 1943. Those nominated: A. Barbalate, a charter member still active in the field of radio with RCA Communications; Ben Beckerman, another charter member who sailed as a radio officer for over thirty years and is now taking a well earned vacation; George H. Clark, Historian of Radio, and one of the original incorporators of our Association; A. J. Costigan, one of our most consistent directors despite his almost continous commuting between Washington and New York; W. S. Fitzpatrick, a charter member—the man who gave Ye prexy his first job as a Radio Officer, and who has done such a swell job of "reminiscing" these past few months in this page, (Thanks, Bill); Robert H. Frey, Supervisor of Radio for the Bull Steamship Company, who despite his travels around the country on business always gets to the meetings (believing that the 'newcomer' in the Frey family will have arrived before this reaches the presses we extend sincere good wishes to the parents. . . Mr. and Mrs. 'Bob' Frey, a grand couple); Charles D. Guthrie, New York Supervisor of radio for the Maritime Commission. . . one of the first government radio inspectors and a pioneer in the affairs of our Association; Henry T. Hayden, an early radioman from the West Coast. . . sales engineer for Ward Leonard Company these many years. . . a faithful VWOA-ian; Charles W. Horn, director of Development and Research of the National Broadcasting Company, a pioneer in the field of broadcasting, a full Commander in the Naval Reserve and recently serving as technical adviser to the Donovan Committee; William J. McGonigle, editor of VWOA News 1930 to date. . . secretary VWOA 1933-1936. . . president VWOA 1937 to date . . . director VWOA 1935 to date and still running; Fred Muller, secretary, president, vice-president and director . . . always in office. . . now Lt. Cmdr Muller, Radio Materiel Officer of the Third Naval District; Frank Orth, a charter member, prominent in broadcast engineering circles, one of the earliest of the veterns; H. H. Parker, now with the Westchester Lighting Company but ready, willing and able to do his all for his country. . . he did a fine job as secretary of our Association for many years; O. W. Penny, of the radio engineering staff of WMCA. . . still a crackerjack operator in Morse and Continental; Peter Podell, also a charter member, one of the real founders of our Association, now serving as an Inspector of Radio Materiel for the Navy Department, (Pete has a son serving in the Signal Corps and on his own behalf he made many attempts to get back into the Service. Pete served in the Navy during World War Number 1); J. R. Poppele, chief engineer of WOR, chairman of our scholarship committee (and if we don't watch out he will be flooding the market with our scholarship graduates. But, seriously, Jack has done a splendid job of seeing to it that worthy and capable young men receive the finest instruction in radio technique under our Marconi Memorial Scholarship plan. Incidentally, Jack recently became a member of the "Twenty Year Club" of which the noted commentator H. V. Kaltenborn is president); William C. Simon, very busy as marine radio superintendent of the Tropical Radio and general manager of the Tropical Radio Service Company who despite these very arduous duties continues most active in Association affairs and also serves in a civilian defense capacity in his home community; Paul K. Trautwein, president of the Mirror Record Corporation, a pioneer wirelessman. . . formerly treasurer and a director of VWOA, now chairman of the finance committee; John Varian, purchasing agent of the Radiomarine Corporation of America, always on hand as an official greeter at our annual Cruises, and V. P. Villandre, now a director, formerly treasurer, one of our most diligent workers.

Personals

Totally blind is 'Doc' James Forsyth, who for over twenty years sailed on some of the finest ships under the American flag as radio officer. Never possessed of very good eyesight

'Doc' nevertheless did an outstanding job in his profession until ten years ago when his failing vision caused him to seek shelter in Sailor's Snug Harbor on Staten Island, N. Y. The only wirelessman in the Harbor, Doc's condition has grown progressively worse until today he is totally blind. He recognizes people only by their voices. . . and in his own words, "There have been precious few of my many friends of the 'good-old-days' whose voices I have had the pleasure of hearing, these many years past." We visited Doc recently and it was with amazement that we learned that he had not had an outside visitor since our previous visit of more than a year previous. Except for his lack of sight, he enjoys the best of health, but naturally, is unable to leave the Harbor. When asked "What can we bring to you, Doc?" he very simply stated that he did not desire anyone to feel that they should bring anything to him. He would be delighted just to hear a familiar voice to reminisce a little about the early days, to talk of mutual friends and interests. And in true humility, when we were leaving he said, "You know, if you do want to bring along a little something when you come again I'd enjoy a few 'cookies'. . . I haven't had a cookie since the last time you were here."

On a subsequent visit within the past month we brought along, on behalf of our Association, a new pipe, some tobacco, a few cigars. . . those cookies he mentioned, and a small amount of a military secret. His gratefulness gave us the grandest feeling we've had in a long time. To those of you who knew Doc in the old days. . . we urge you to drop over for a short visit. We guarantee you will be well rewarded. During times when you can't visit him drop him some little thing . . . a five cent cigar with a short note now and then would be better than a five dollar gift every five years. Whether or not Doc knows you personally, if everyone reading this item will send him a Christmas card. . . or word of greeting, we assure you it will do much to make life worth living to a "grand guy." Written communications to Doc will be read to him by his "Leader." Address him . . . James Forsyth, Radio Officer, Sailor's Snug Harbor, Staten Island, N. Y.

One never knows where you will find veteran wireless operators. One such is Lewis Winner, Editor of COMMUNICATIONS, and we now take pleasure in greeting him as a veteran member of VWOA. . . Very pleased to know that the Boston chapter is still most active. Just recently received a phone call from Albert Allen, formerly of the Boston chapter now stationed in New York

(*Continued on page* 37)

THE INDUSTRY OFFERS . . .

ARH TELEGRAPH KEYS

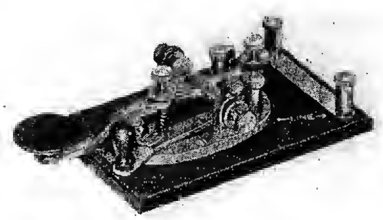
Telegraph keys, type J-38, are now being produced by the American Radio Hardware Co., 476 Broadway, New York City.

This new key is equipped with a shorting lever for receiving. The mounting base is cut from ¼" grade XX black bakelite. An eyelet in the base prevents the phone cords from pulling loose. The frame of the key is a solid casting, and the bearing parts are of brass.

The key lever is alloy steel ⅛" thick. Contacts are of pure coin silver, and the shorting lever is of nickel plated brass, with the spring or lip with which it closes the circuit of a spring temper nickel silver.

A newer feature of this key is the replacement of the customary hard rubber insulating washers on contacts and binding posts by a laminated electrical grade bakelite.

There are other models, including the J-44, J-45, and J-37.



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RCA CATHODE-RAY TUBES

Three new cathode-ray tubes for use in connection with WPB rated orders have been released by RCA Manufacturing Co., Inc., Harrison, N. J.

They are 3BP1, a 3-inch, high-vacuum tube having electrostatic deflection, electrostatic focusing, green fluorescence, and medium persistence. It has a 2-inch diameter bulk neck, separate leads to all deflecting electrodes and the cathode, and an overall length of about 10 inches. All leads terminate in a Diheptal base.

The next type is the 3EP1/1806-P1, which is similar to the 3BP1, except that it has a different bulb with 1⅜-inch diameter neck and a magnal base. Separate leads to all deflecting electrodes are provided, but the cathode is connected to the heater within the tube.

The third type is the 7CP1/1811-P1, a short 7-inch, high-vacuum tube with magnetic deflection, electrostatic focusing, green fluorescence, and medium persistence. It has a 1⅜-inch diameter bulb neck and an overall length of about 13½ inches. Except for anode No. 2, which is connected to a snap terminal on the side of the bulb, the other electrodes, including the cathode, all have separate leads terminating in an octal base.

* * *

WORK MAGNIFIER SOLDERING IRON STAND

A magnifier, through which an operator can see small parts and fine wires for soldering is a feature of an electric solder iron stand developed by Photobell Corporation, 116 Nassau Street, New York City. Diagrams of connections on a white card, placed behind this magnifying glass also assists in providing instructions.

Other features are shadowless lighting under a hood, chimney that removes all soldering fumes, etc.

AEROPOINT INSTRUMENT PIVOT MANUAL

The publication of a complete pivot manual covering specific and technical information on the application of long life PERMIUM alloy pivots as used in all types of instruments has been announced by The Paraloy Company, 600 S. Michigan Ave., Chicago, Ill.

These bulletins are sent free to all instrument men, manufacturers, engineers, and users of instruments upon request on their letterheads.

* * *

PARAMOUNT PAPER TUBE SIZES EXTENDED

Tubing sizes as small as 3-16" square inside and as large as 4" square inside, with a tolerance as close as .002" are now available from Paramount Paper Tube Co., 800 Glascow Ave., Fort Wayne, Indiana.

These paper tubes can be supplied immediately in high dielectric kraft, fish paper, red rope, acetate or combination wound in square, round, or rectangular shapes and in continuous lengths or in any wall thickness. The tubes have square corners and straight side walls.

Samples of the tubes or a complete Arbor List of over 650 sizes will gladly be sent on request.

* * *

UNIVERSAL CUTTER-GRINDER

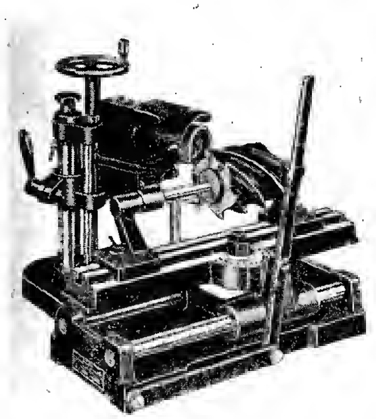
New Hilco Universal cutter-grinder has been announced by the Berco Manufacturing Co., 429 W. Superior St., Chicago, Ill.

Furnished with an interchangeable table or flat bed attachment and a special universal index dividing head, the Hilco, regardless of type tool ground last, may be set up in just a few minutes it is said, for any other type cutter. It will grind to any concave, convex, helical, straight, tapered, angle or special cutter up to 6" in diameter and any saw up to 18" in diameter, regardless of cutting angle required.

The dividing head has seven index circles consisting of micrometer placed holes or stops which insure uniformity of cutting edges in the finished cutter.

The Hilco is a bench type machine and is 21" long, 17" deep and 17" high and weighs approximately 135 pounds.

A circular fully descriptive of the grinder and showing a number of possible set-ups may be obtained by addressing the manufacturer.



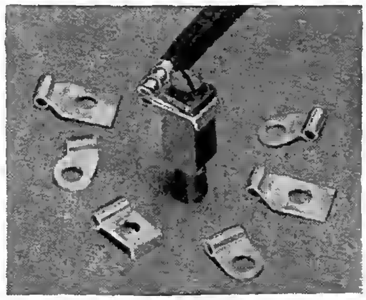
SOLDERLESS FLAG TERMINAL

A solderless flag type terminal for stacking a series of parallel terminal connections on a single stud block without loss of space or electrical conductivity, has been announced by Aircraft-Marine Products, 286 N. Broad Street, Elizabeth, New Jersey.

These solderless terminals may be used for either right or left hand application, since the terminal barrel is symmetrically located with respect to the plane of the tongue. This eliminates the necessity of distinguishing between and stacking two different terminals, thereby simplifying installation and speeding production.

For wire sizes 22 and 10, these new terminals are pure copper of maximum conductivity and hot electro-tinned for maximum corrosion resistance.

No solder is necessary—the terminals are crimped on wire with hand, foot or power tools. Special designs for particular applications are available.



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NEW TYPE DI-ACRO BRAKES AND SHEARS

New model brakes and shears have been released by O'Neil Irwin Manufacturing Company, Minneapolis, Minn.

The brake, No. 3, is said to have an accuracy guaranteed to tolerance of .001" in all duplicated work. Its maximum folding width is 18". Its maximum full width folding capacity, using both brake handles is 24 gauge steel plate.

Maximum folding capacity to 12" width using both brake handles is 18 gauge steel plate. Heavier gauges of narrower or more ductile materials in proportion.

Complete adjustments of all contact surfaces are provided, allowing vertical and horizontal adjustment for duplicating either obtuse or acute angles, as permitted by natural working radii over the entire capacity range of material formed. Precision adjustable stops are provided for holding to die tolerances, the degree of angularity in all duplicated work.

The Di-Acro Shear, No. 2, shown below, also is said to have an accuracy guaranteed to tolerance of .001" in all duplicated work. Its maximum shearing width is 9".

Maximum shearing capacity, full width, 22 gauge steel plate. Spring charged action automatically returns shear blade for next operation, providing faster operations and higher material output. Shear blades are reversible offering double service without resharpening.

This shear can be arranged for shearing, squaring, slitting, stripping or notching to extremely close tolerances. All ductile and pliable metals and materials can

(Continued on page 50)

VWOA NEWS

(*Continued from page* 35)

with the Columbia Broadcasting System. He brought with him best wishes to the New York members from Guy Entwistle, president of the Massachusetts Radio and Telegraph School, who has been doing a splendid job of training young men for the radio operating profession for over a quarter of a century. Thanks, brother Allen, and a very cordial invitation to be with us on February 11th at the Hotel Astor on the occasion of our eighteenth anniversary Dinner-Cruise. . . . Leroy Bremer, who did such a grand job as secretary of our Los Angeles chapter for several years, dispatches a beautiful Christmas card to ye prexy from New Zealand, for which many thanks, L. B. Leroy, after many years ashore, felt the urge to contribute more to the war effort, and for the past year has been a Chief Radio Officer. Good luck, Leroy and best wishes for a Merry Christmas and a Happy New Year. And the same greeting goes to our entire membership from your officers and directors.

Dues

Do you know, gentlemen, that we are still waiting for that personal item about your doings? Please let us have more information on what is happening among our members. Don't bother to make a literary masterpiece of some interesting item you believe should appear in this page. Just send it along and we'll do our best. . . . Also, if you haven't sent in dues recently take a gander at the bottom of the Ballot and, if there it says you owe some dollars, YOU DO! Please send it along as soon as possible because George can't do it for you. But George Clark will be most happy to send you a current membership card. So do it NOW!

Congratulations

Our association tenders sincere congratulations to two pioneers in aviation radio: Lieut. General Henry H. Arnold, Chief of Army Air Forces and Major General Follett Bradley, Commanding General of the First Air Force stationed at Michell Field, N. Y. It was on November 2, 1912, that Lieut. H. H. Arnold as pilot and Lieut. Follett Bradley as Observer and Radio Operator participated in the first experiments in the use of aviation radio for communication in artillery spotting from the air. The advances in the art which they pioneered have been many, and the personal advancement of these pioneers is gratifying.

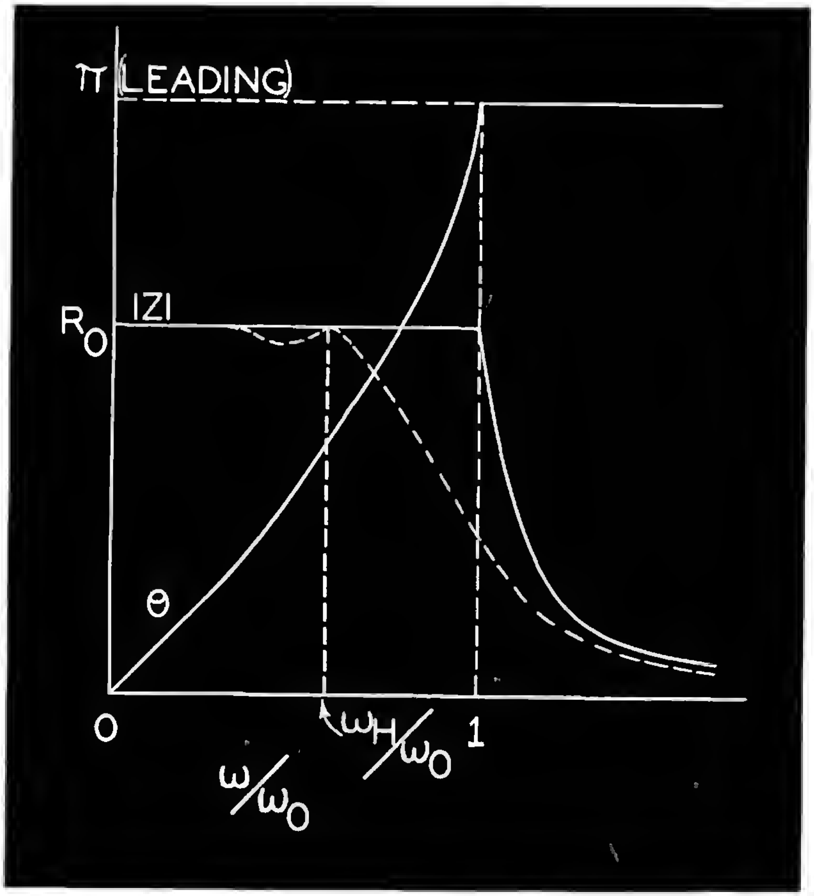


Figure 9

The plot of eq. 10, in which we see that the load impedance in the plate circuit of a video amplifier stage will have a perfectly flat gain up to the cut-off frequency ω_0 and then drop off asymptotically to zero.

VIDEO HIGH FREQUENCY RESPONSE

(*Continued from page 20*)

quency although its phase angle increases with increase of the above ratio. The actual plot of Eq. (10) is given in Figure 9. It is at once evident that such a load impedance in the plate circuit of a video amplifier stage will have a perfectly flat gain up to the cut-off frequency ω_0 and then will drop off asymptotically to zero. This indicates a very desirable state of affairs, but it must not be overlooked that the phase shift is not strictly linear with frequency in the pass band and will thus offset to a certain extent its favorable amplitude characteristic.

The above analysis was based on a perfect image termination of the modified filter section. As stated previously, in actual practice such a perfect termination is not possible and so the question may arise as to what effect an imperfect termination has if such as that of a fixed resistance equal to R_0 be employed. The result is to cause a drop-off in amplitude response below the cut-off frequency. Indeed, for the half-section filter a pure resistance termination causes a drop-off at approximately half the cut-off frequency together with a small irregularity in the response just below this point. The effects on the amplitude response are shown by the broken line curve in Figure 9.

Use of M-Derived Termination

Flatness of response to a frequency closer to that of cut-off may be obtained if a better approximation to the image impedance termination than that of R_0 is made. It is desirable that this be accomplished with an economy of circuit parameters. Such is the case when an m-derived section followed by R_0 is employed for the termination. In Figure (10) on the right is shown a series m-derived section whose image impedance is the same as that of the constant k section to the left, although its transmission characteristics are different. The value of m can be any number between zero and unity for ordinary physical realizability.

However, the impedance looking into an m-derived section terminated in R_0 is more nearly that of the true image impedance up to a point very close to the cut-off frequency than is that for its prototype, the constant k section, similarly terminated, particularly for $m = 0.6$. Hence, if we take a half section and terminate its T end with a series m-derived half section terminated itself in the normal image impedance R_0, then the impedance looking into the π end of the constant k half section will be very closely that of a perfectly terminated section up to pretty nearly its cut-off frequency. If an equal amount of capacity be added to its π end (as per the method of Percival) then the impedance will be very close to that given in Figure 9. The circuit is shown both in synthesis and in final form in Figure 11, where the values for the various circuit parameters are also indicated. As stated in the Figure, the frequency f_H at which the response begins to fall off is about 95% of the cut-off frequency according to Wheeler[3], and experimentally it has been found

(*Continued on page 41*)

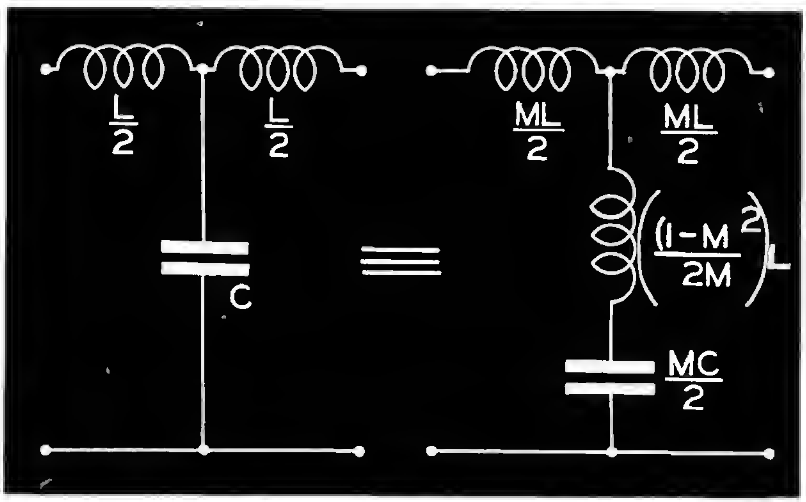


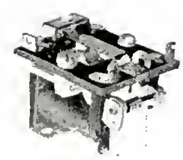
Figure 10

★ Smothered in dust . . . seared by gun blast heat . . . shrouded in fog . . . gripped by stratosphere cold . . . shaken by blasts of bomb and shell . . . these are daily incidents in the life of a relay. Under these conditions Relays by Guardian have already "proved their metal."

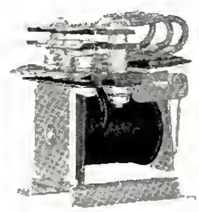
THE SERIES 195 RELAY weighs less than an ounce! But don't let its tiny size fool you. It shrugs off the most severe vibrations likely to be encountered in aircraft. And it's especially adaptable to jobs where space as well as weight is at a premium. It's about wrist watch size in length and width—and not a great deal thicker.

SERIES 345 RELAY. A radio relay for use in aircraft. Maximum contact combination of three pole, double throw, combined with large coil winding area makes this a highly efficient relay in compact space.

While thinking, building and engineering the tools of war today, Guardian is also looking ahead to peacetime applications of Relays, Solenoids, Electrical Controls of all kinds. If you are planning for the future too, write us—our war-time experience can help you build better peacetime products.



Series 195 Relay. *One of the smallest relays made. Write for new Bulletin.*



Series 345 Relay. *For radio aircraft use. Write for new Bulletin.*

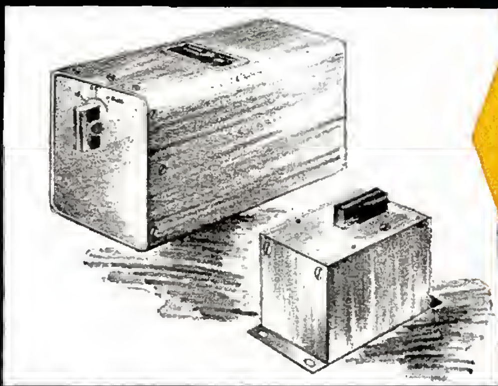
GUARDIAN ELECTRIC

1623 WEST WALNUT STREET — CHICAGO, ILLINOIS

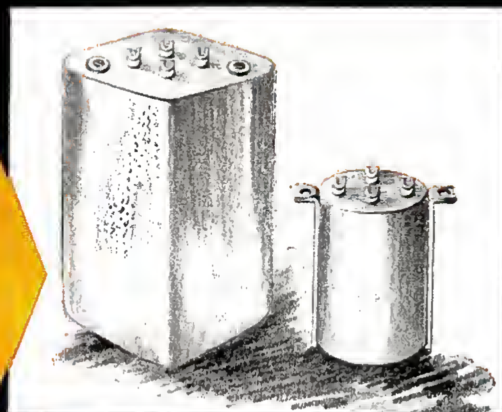
A COMPLETE LINE OF RELAYS SERVING AMERICAN WAR INDUSTRY

Waste is as damnable as sabotage

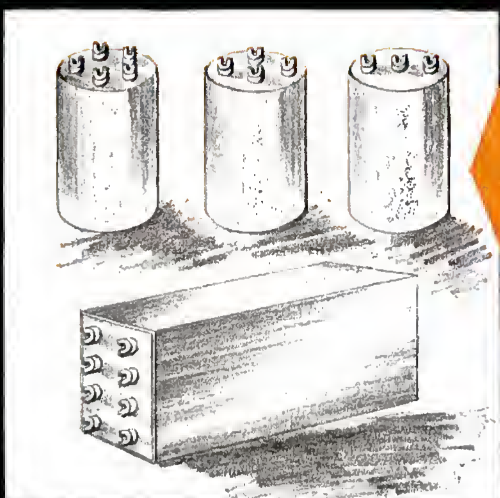
Electrical and mechanical design are the foundation of our military production. Small individual savings, when multiplied in mass production, add up to large savings in critical materials and labor time. Here are some examples from our organization:



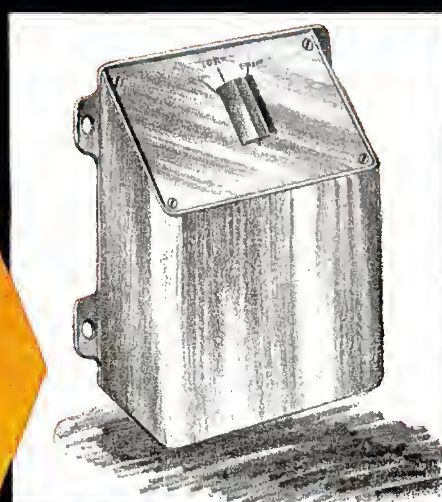
Cumulative electrical and mechanical redesign reduced the quantity of critical materials in this unit 60%, reduced total size and weight in direct proportion.



Through proper mechanical redesign, the weight and volume of this unit were halved, yet the same mounting centers were maintained for field replacements.



This application employed three of our Ouncer units. By combining the three in one case, we eliminated two aluminum housings, four terminals, two terminal strips, etc.



Electrical redesign reduced the amount of nickel iron alloy used in this filter by 50% . . . the mechanical redesign eliminated a dozen brass brackets and screws and cut installation time one-half hour.

UNITED TRANSFORMER CO.

150 VARICK STREET ★ NEW YORK, N. Y.

EXPORT DIVISION: 100 VARICK STREET NEW YORK, N. Y. CABLES: "ARLAB"

VIDEO HIGH FREQUENCY RESPONSE

(*Continued from page* 38)

to be as close as 89% of the cut-off frequency.[4] In passing, we note that it would be absurd to add additional capacity at the head end to satisfy the requirements laid down by Percival. This capacity is the quantity C_t previously described and we merely divide it mentally in half and use one half for the filter section and the other half to flatten the driving point impedance per Eq. (10). This means essentially that the values of the inductances L_1 and L_2, and of C_2 and R_0 (in the case of the series m-derived section) are modified from the values that they would assume if all of C_t were considered as making up the front end of the filter section.

Suggested Configurations

The method previously outlined may not be shufficiently accurate in the case of many stages in cascade, but it does at least suggest circuit configurations which may be of value. Thus, our amplifier stage must always start with a shunt capacitance C_t, that is, as a π section. Theoretically, its magnitude can be kept constant up to the cut-off frequency if perfect termination is employed. In practice, the better the actual termination approximates the theoretical image impedance termination, the greater the band-width over which the stage will be flat, with, of course, the cut-off frequency as the upper limit. The poorest approximation to the true image impedance is that of a simple resistance of value R_0. A much better approximation (and indeed one that is almost perfect from this viewpoint) is the m-derived section. Other possibilities are those of interposing between the head-end half section and the single nominal image impedance R_0 of one or more constant k sections. The more sections interposed, the closer is the termination to that of the true image impedance. In Figure 12A we see the simplest form previously described and often known as the shunt peaking circuit. In (B) we see the half section followed by another half section thus forming a complete π section before termination with R_0. The band width is thereby increased. In (C) we see the circuit of B further built out with an additional half section before termination with R_0, and the band width is correspondingly greater. In (D) we see a simpler configuration which is equivalent to that shown in Figure 11 in which a shunt m-derived section is employed. The optimum value of m in either case is about 0.6. A more accurate evaluation of the circuit parameters of this configuration will be given further on.

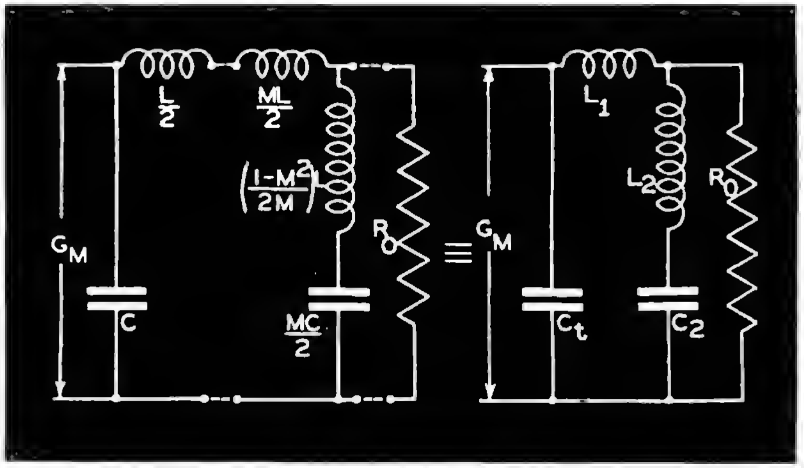


Figure 11
M-derived circuits, both synthesis and final form.

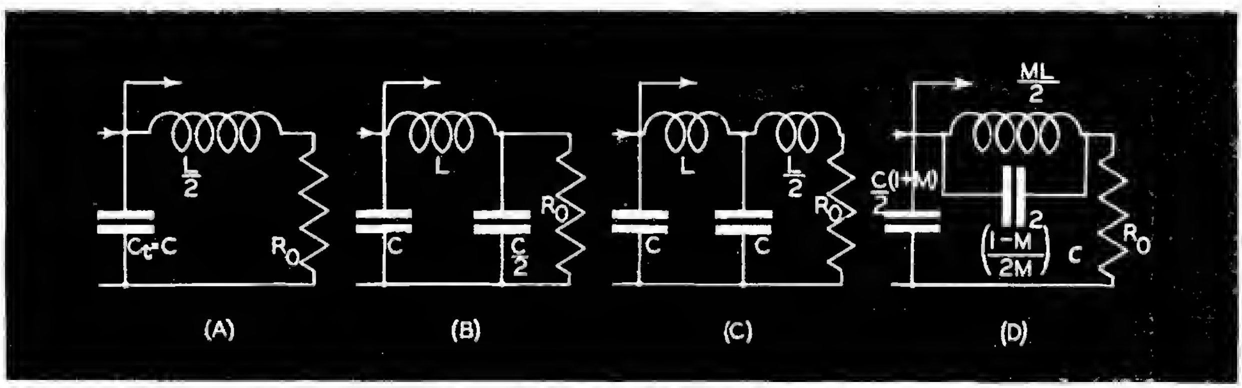
Thus far, the discussion has concerned itself with two terminal networks, i.e., the output voltage is taken off the front end of the network and C_t as mentioned previously, consists of the output capacity of the first tube, the input capacity of the following tube, and the stray wiring capacity, all in parallel. The maximum impedance that can be realized over the full band width is given by Eq. (10) where R_0 equals $\sqrt{L/C}$. Eq. (10) may obviously be rewritten as

$$Z = \frac{2}{\omega_0 C_t} \angle -\sin^{-1}\left(\frac{\omega}{\omega_0}\right) \quad (11)$$

where C_t is the head-end capacity. Evidently if this could be reduced, the gain for a given band-width or the band-width for a given gain could be increased. This can be brought about if the input capacitance of the second tube and some of the stray wiring capacity are separated from the rest of the stray wiring capacity plus the output capacitance of the first tube. The method employed is to locate these two sets of capacities at opposite ends of a π filter section as shown in Figure 13A, B, C and D. Such circuits are sometimes called series peaking circuits from the fact that the inductance L appears to be in series between the two tubes. A more important difference between these circuits and those shown in Figure 13, is that here transmission of the signal is via a four terminal network so that the transmission of the signal through the filter section rather than the driving point impedance is the important characteristic to study. While the gain of such a four terminal network is inherently greater than that of the two terminal networks previously discussed, in practice not all of this theoretical advantage may be realized. In Figure 13A is shown the most obvious form. It will be noted that the capacity of the second tube according to

(*Continued on page* 45)

Figure 12
Shunt peaking circuits.



FIRE FIGHTING PACK EQUIPMENT

(*Continued from page* 11)

tube mounts upside down. This was done to save space. The entire construction is very rugged and not subject to dislocation from jarring of vibration.

Elaborate tests were conducted to determine frequency shift due to foreign bodies and heating. Frequency deviation due to heating of tube and circuit elements after one minute of operation is 20 kc. However, if the transmitter is allowed to run, it will resume its original frequency after five minutes and then drift upward about 10 kc for the next five minutes. At that point the frequency drift is negligible. Due to the negative temperature coefficient of the tuning condenser, external temperature changes have only a slight effect on frequency.

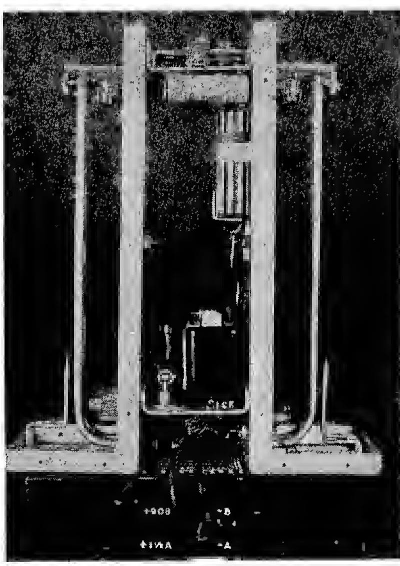
Audio Unit

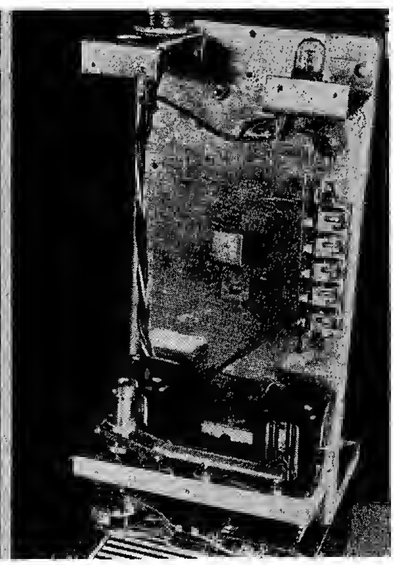
A 1T5GT is used as a combination modulator and audio amplifier. The grid input of the audio transformer is bypassed with a .003 mfd. condenser. This was found to be the smallest value of capacity that could be used to remove the quench frequency from the audio stage. We used our oscilloscope for this by noting the amount of quench frequency present in the output of the audio stage and its attenuation with various values of capacity. We alternately fed in a straight audio signal at various frequencies from 300 to 10,000 cycles and noted that with the .003 mfd. condenser there was complete attenuation of the quench frequency with no appreciable effect on audio frequencies between 300 and 4,000 cycles, except for an increase in output for those frequencies between 1,000 and 2,500 cycles.

A pair of high impedance phones is used in the output for maximum transfer of energy from the special output choke, which doubles as a modulation choke (Heising) for the transmitter. A .004 mfd. condenser is used across the phones to further accentuate voice frequencies.

The microphone, a single button carbon, operates at the filament voltage, 1½ volts. This is done for two reasons. The noise level at a fire is high and pack operators have a tendency to shout into the microphone. To cut down the external noise pick-up, and at the same time compensate for the shouting, it is necessary to reduce the microphone sensitivity. The lower operating voltage helps accomplish this.

By means of a standard automobile remote tuning cable, the operator can throw the ganged dpdt switches from transmit to receive. The rotating cam, which is easily detached from the tuning cable, rides on a split volume control shaft, and permits rotation of this arm in either the transmit or receive position. "C" bias was originally supplied by a special 6 volt battery. Our new





Figures 13 and 14.

Figure 13, left, a front view of the interior of the pack set. Figure 14, switching mechanism and the audio system.

models use five 1¼-volt bias cells which give equivalent results.

A neon light in a relaxation oscillator circuit serves as a pilot light and battery voltage indicator. The blinking action attracts the operator's attention if the pack is accidentally left "on." Since the neon will not work on 65 volts or less, we also know when it is time to change the battery. The low battery drain, 40 microamperes, makes it ideal for portable packs.

Antennae

The problems of a good antenna for use with a pack set have been one of the hardest to solve. Such an aerial for a fire-fighting pack radio must of necessity be short; otherwise it would be a life-hazard. A half-wave antenna at 117.550 mc would measure 127.5 cm or 50 inches; obviously too long. A quarter-wave antenna measures only 25 inches approximately and is just the right size.

Since the maximum power available from the oscillator is 250 to 325 milliwatts, good use has to be made of every milliwatt. Further, not all this power can be used, since frequency stability is important. An antenna loaded into an oscillator directly causes serious frequency shifts and our problem was maximum output for maximum frequency stability.

In the course of our experiments, some peculiar effects were noticed. Using various antennae, the frequency deviation due to the presence of foreign bodies near the antenna, was at times downward and in other cases upward. The frequency deviation upward was particularly noticeable with shunt-fed Marconi's and downward with quarter wave end-fed antennae.

Several other types of antennae were tried, but the problem resolved itself into the use of end-fed or shunt fed Marconi's. Both types have been tried and found effective. Frequency deviation is greater with the shunt fed antenna than with the end-fed in the presence of foreign bodies, but the former has greater field strength radiation.

Both types use coaxial feeders since this was found to reduce losses and make for easier construction. Loops are used for coupling so connected that the coupled impedance has a capacitive reactance into the oscillator circuit. The surge impedance of the coaxial feeder is 35 ohms for the end-fed antenna and 90 ohms for the shunt fed antenna.

Credits

This development work would not have been possible of accomplishment without the aid and cooperation of the Civic Administration and the Fire Department of the City of New York.

[To Be Continued]

FILAMENT VOLTAGE CONTROL

(*Continued from page* 14)

ing and cooling tends to distort thoriated filaments.

Oxide-Coated Cathodes

Many characteristics of oxide-coated cathodes are similar to those of thoriated-tungsten just discussed, and some of the suggestions apply equally to both types of cathode. This is particularly true of the oxide-coated cathodes used in gas-filled and mercury vapor tubes. In tubes of this type, cathodes are usually operated at a higher temperature than in vacuum tubes, in order to provide rapid replenishment of emissive material and to compensate for the chemical contamination and positive ion bombardment encountered in gaseous tubes. Operation at too low a temperature usually results in rapid deterioration of the cathode; complete failure occurring within a very short time. In extreme cases the tube may give some warning in the form of sputtering of the cathode, but under less severe conditions the tube will not show any signs of distress even though its potential life may be seriously reduced. The effect of excessive voltages is the same as in the case of thoriated tungsten, namely accelerated evaporation of emissive material resulting in reduced life, and increased danger of activation of other tube elements. In thyratrons activation of the grid means loss of normal grid control, while in all gaseous tubes activation of the anode causes arc-backs and destruction of the cathode. It is therefore desirable to operate the filament as close to the rated value as possible in order to avoid the paths to ruin that lie on each side of this value. A tolerance of plus or minus 5 per cent is usually allowed for line voltage variations in gaseous tube applications. If voltage variations greater than this are known to exist, the voltage should be set higher than the rated value in order to insure ample emission even under the most adverse conditions. It is better, however, to provide automatic voltage regulation so that the filament need not be operated above the rated value. Such provision will insure the maximum useful life.

High-Vacuum Tubes

In the case of high-vacuum tubes, oxide-coated cathodes are usually operated at somewhat lower temperature in order to avoid trouble from grid emission. Such operation is possible because of the absence of positive ion bombardment and the lessened danger of chemical contamination of the cathode. Tubes of this type are in general low-voltage, low-power tubes, and they are frequently operated considerably below ratings. Under these conditions it is often possible to reduce the filament voltage and obtain increased life. The same precautions as were noted in the discussion of thoriated-tungsten filaments should be observed, but the likelihood of damage resulting from emission limited operation is considerably reduced. While reduced voltage may be advantageously employed if proper care is exercised, operation above rated voltage is very dangerous. Increased evaporation of barium from the cathode can easily activate almost any grid material so that the tube may be rendered worthless because of grid emission even though the cathode still has many hours useful life.

Summary

A brief summary of the foregoing suggestions is given in Figure 7. Additional recommendations applicable to all types of cathode are reviewed in the conclusion.

Conclusion

In the majority of cases, the most important factor in obtaining good operation and long life of electronic tubes is the use of the correct filament voltage. Many of the tube troubles commonly encountered are simply the result of improper filament voltage. It is essential that the filament connections be clean, and strong enough to assure good electrical contact. All voltage measurements should be made *at the tube terminals* in order to eliminate possible errors caused by poor connections or inadequate wiring. Regulating transformers which minimize the effect of line voltage variations are available, and will frequently pay for themselves many times over in terms of increased tube life. Where automatic voltage control cannot be secured, constant checking of filament voltage, and diligent care in the operation of electronic tubes will adequately compensate the user and materially aid the war effort through conservation of scarce materials.

Effective practical illustrations of the import of increased and decreased filament temperature with some popular type transmitting tubes were presented by Charles W. Singer at the Ohio State University broadcast engineers conference, in March, 1942. A complete report on this study appeared in the March, 1942, issue of COMMUNICATIONS.

VIDEO HIGH FREQUENCY RESPONSE

(*Continued from page* 41)

the method of Percival should be half of that of the first tube, a condition frequently violated in practice. Because of this latter fact, the increase in stage gain is therefore not very much over that of some of the two terminal networks previously discussed. The network can be turned end-around as shown in B. The performance will be identical and is based upon what might be called a constant current reciprocity theorem, which states that in a four terminal network, the voltage evoked at one pair of terminals by a current flowing through the second pair is the same as that produced at the second pair if the current be passed through the first pair. This theorem can be very simply proved in a variety of ways, such as that depending upon the ordinary reciprocity theorem concerning the current produced in one mesh by a voltage introduced in another mesh.

From a practical viewpoint, Figure 13B differs from 13A in the following way. If the output capacity of the first tube is twice that of the second, then Figure 13A is indicated and R_0 is placed adjacent to the second tube. If, on the other hand, the output capacity of the first tube is half of that of the second tube, then R_0 is simply placed adjacent to the first tube and Figure 13B is obtained. Thus, two ratios of output to input tube capacities can be accommodated by simply shifting R_0.

[*TO BE CONTINUED*]

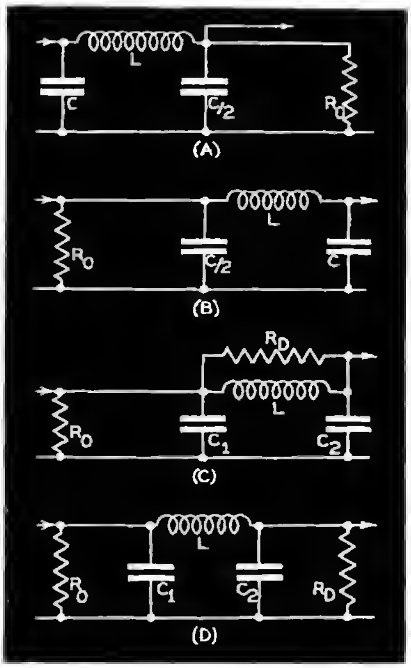


Figure 13
Series peaking circuits.

AIRCRAFT RADIO DESIGN

(*Continued from page 26*)

is particularily applicable for this service. The features were described in the October issue of COMMUNICATIONS.

Gain control voltages are applied to the r-f stage and the l-f stage. A portion of the 12SK7's screen voltage is developed across the bleeder resistor R20 to the volume control resistor and completes the circuit through the negative "B." The voltage drop across the volume control resistor and R20 is dependent in magnitude to the ratio existing between the two values of resistance. To obviate a tendency for a "lumped" volume control action the resistor R20 value must not exceed a variation of "plus" or "minus" 5% of the normal resistance. Excessive heat is the most generally encountered cause for a change in the value of the resistance as used in this application. A good margin in respect to power dissipation must be considered. A test method used to determine whether the volume control action is smooth and possesses balanced characteristics over the volume control range is accomplished by plotting the results of microvolts input up to a value of 1,000,000, with the volume control setting as a function of percent rotation in order to maintain a constant output. The desired characteristics are shown in the accompanying curve. This is a curve of resistance against control rotation of the volume control type that is used in the S-101 receiver.

S-102 Receiver

This unit is a three-channel pretuned type designed especially for use aboard aircraft for reception of voice transmission from the airport control tower. Basically this receiver comprises three independent r-f sections (two low frequency channels and one ultra-high-frequency channel). A common audio

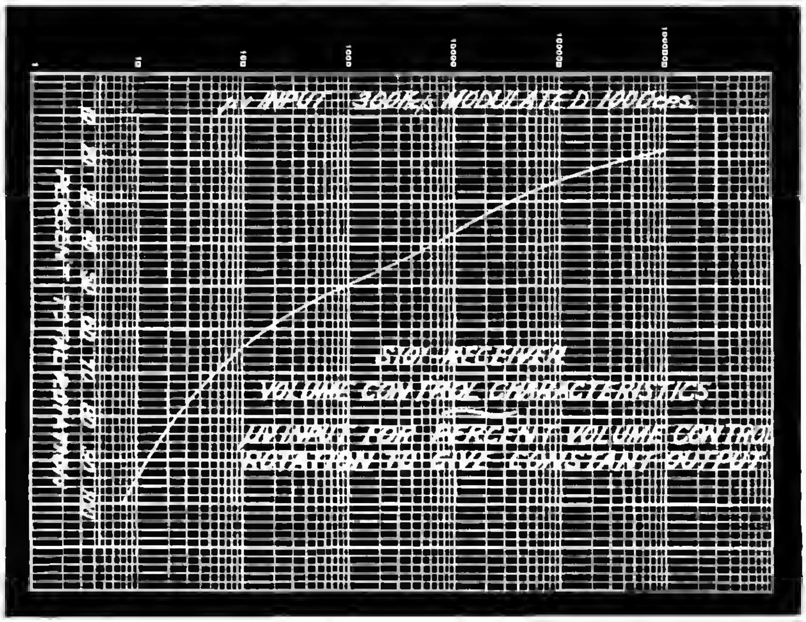


Figure 9
Volums control characteristics of S-101.

AIRCRAFT RADIO DESIGN

(*Continued from page* 46)

system is used, including one stage of audio amplification that drives the dual audio output stages. Automatic volume control, supplemented by a manual volume control, is also provided. The audio output tubes, in addition to serving their primary intended purposes in this circuit, also function as an amplifier for the interphone communication system of the aircraft. The S-102 receiver is housed in a case similar to that used with the S-101 receiver and uses an apparatus mount identical to the S-101 type.

Characteristics

The two independent low frequency channels are normally pretuned for the reception of 278 kc and 362 kc. However, other frequencies on a pretuned basis are available by the use of appropriate coils. The sensitivity is less than 12 microvolts. A tuned radio frequency circuit is used, because communications range coverage is required only in the vicinity of the airport. This type of circuit does not present a problem of interference between the heterodyne oscillators as the case would be for a superheterodyne.

Another feature is that the pretuned t-r-f circuit is sufficiently stable to void the necessity for crystals. They would be needed for the heterodyne oscillator if a superheterodyne type circuit was used.

Each of the two low-frequency channels consist of two stages of r-f and a detector stage. The type 12SQ7 tube serves the purpose of providing a diode detector, diode for avc and a triode for the first audio stage.

The ultra-high-frequency channel of the S-102 receiver employes a superheterodyne type circuit and consists of input circuit, first detector, crystal controlled heterodyne oscillator and a harmonic amplifier, intermediate frequency amplifier, second detector, automatic volume control and an audio amplifier. The input transformer is fed from a 70-ohm antenna transmission line. The first and third of the three inductive coupled windings of this transformer are tuned to resonance at 75 mc. The function is to provide a method of matching the transmission line and to inductively couple the signal energy into the grid circuit of the first detector. The second circuit of this transformer is resonanted to the image frequency for the purpose of attenuation of this frequency. The first detector cathode receives the heterodyne oscillator voltage which is below the received signal frequency by the amount of the intermediate frequency. One advantage of using the low side is

(*Continued on page* 48)

AIRCRAFT RADIO DESIGN

(Continued from page 47)

that it makes it possible to use a heavier crystal. Another reason is that the image is less as compared with the use of a higher frequency.

A twin triode tube is used in the crystal controlled oscillator amplifier. An "A-T" cut crystal is connected in the grid circuit, which is one ninth of the frequency minus the i-f that is ejected into the cathode circuit of the first detector. In the plate circuit are two tuned circuits that are resonated at the crystal frequency and at the third harmonic respectively. The plate circuit of the harmonic amplifier, that is inductively coupled to the first detector cathode circuit, is tuned to the ninth harmonic of the crystal frequency. Two stages of intermediate frequency amplification are used. The transformers are of the iron core type, in which both the primary and secondary are tuned.

The method for remote control selection of either one of the low frequency channels or the u-h-f channel is by the use of relays that controls the plate high voltage supply. These channels, when selected by application of plate voltage to the audio power, provides audio power to the dual audio output stage. Type 12A6 tubes are used in the output.

The high voltage supply is obtained from a vibrator power pack operating from the plane's twelve-volt electrical system. The power pack is a compact unit with plug-in features. It is interchangeable for either the S-101 or S-102 receiver. A non-synchronous type vibrator with associated transformer and a rectifier tube are used. Adequate filtering is provided in the output as well as the 12-volt input circuit. The latter is necessary to avoid the vibrator hash from entering the electrical system. This would cause interference in other equipment. It will be noted that the control "ON-OFF" switch is in the power input circuit to the vibrator and the tube filament circuit is directly connected. With this arrangement the plate voltage is applied to tubes with pre-heated filaments. The result is that the various by-pass condensers are not subject to high voltage surges. Although the condensers voltage ratings are above the surge limit, it is advisable to avoid this strain.

All photos are courtesy of Wilcox Electric Company.

[This is the fourth of a series of articles covering an analyses of aircraft communication equipment and components. Serving as an advisory editor for this series is Frank Melville, transatlantic aircraft communications expert, and president of the Melville Aeronautical Radio School.]

NEWS BRIEFS

(*Continued from page 33*)

described are audio, bias, poly-pedance, filament, interstage, microphone, driver, modulation, etc., types. A transmitting and rectifier tube chart and a matched power supply chart are also included in this newest brochure. Copies are available gratis, on your letterhead.

* * *

JENSEN ADVANCES "CHARLIE" HANSEN

"Charlie" Hansen who for the past nine years has been associated with Jensen Radio Manufacturing Company, Chicago, and recently as manager of the Jensen Los Angeles office, has been placed in charge of the special management division in the home office.

"Charlie" Hansen (left) and Thomas A. White, sales manager of Jensen.

* * *

FEDERAL WINS "M" PENNANT

The Maritime Commission "M" Pennant and Victory Fleet Flag for excellence in war production has been awarded to Federal Telephone and Radio Corporation.

* * *

G. E. MOBILE ELECTRON MICROSCOPE

A mobile electron microscope that operates on ordinary house current was recently announced by Drs. C. H. Bachman and Simon Ramo of General Electric.

According to Dr. Ramo, development of the new device makes it possible for small laboratories and war plants to take advantage of this type of instrument which is capable of producing images 10,000 times the size of the subject.

The G-E electron microscope uses electrostatic focusing to the beam of electrons instead of electromagnetic focusing.

* * *

PERLES ASSISTANT CBS PUBLICITY DIRECTOR

Arthur Perles has been appointed assistant director of CBS Publicity.

Perles was formerly in charge of CBS shortwave publicity. He joined CBS four years ago as publicity copy editor after 15 years in the newspaper and magazine editorial fields.

* * *

PYLE TO NEWA POST

Charles G. Pyle, general sales manager of Sylvania Electric Products, Inc., has been appointed Managing-Director of the National Electrical Wholesalers Association.

* * *

GOLENPAUL AGAIN HEADS SALES CLUB

Charles Golenpaul, sales manager, Aerovox Corporation, has been elected to the chairmanship of the Sales Manager's Club, eastern division, for a third term.

The Sales Managers' Club Eastern Division meets the fourth Tuesday of the month at the Hotel New Yorker in New York City. The November meeting featured an impressive gathering of leaders in the trade, including representation from NRPDA, the Representatives' Club, and various radio publications. There was an extensive discussion of present problems and possible solutions.

* * *

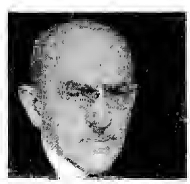
TEMCO MOVES

The offices, laboratory, and factory of Transmitter Equipment Mfg. Co., has been moved from the previous location in Long Island City, to 345 Hudson Street, New York City.

* * *

THROCKMORTON ELECTED RCA DIRECTOR

Following a meeting of the board of directors of the Radio Corporation of America, David Sarnoff, president of the Corporation, announced that George K. Throckmorton, chairman of the executive committee of RCA Manufacturing Company, Inc., was elected a director of the RCA.



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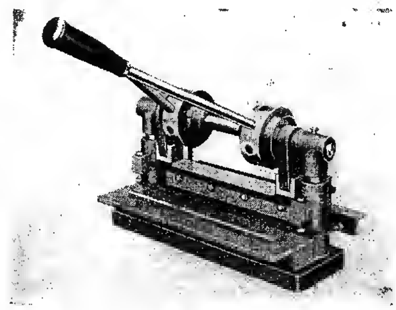
(*Continued on page 53*)

(Continued from page 36)

be worked, including spring tempered metals, fabrics, plastics, leathers, rubber and the very lightest of tissues, frequently eliminating the preparation expense and time delay of preparing blanking and forming dies. It is highly adaptable for rapidly developing accurate shapes in bimetals, sensitized materials, mica, varnished cambrics, fiber slot insulation and other dielectrics and materials.

Power-driven Di-Acro shears can also be furnished as a complete unit with shear, countershaft and motor mounted on a rigid floor-type stand.



* * *

VARNISHED SILK ALTERNATES

Varnished rayon, varnished cotton cloth and varnished nylon have been developed by the Irvington Varnish & Insulator Company for electrical insulation formerly provided by varnished silk. All these materials possess good dielectric strength with tensile and tear strengths equal to or better than varnished silk and can be punched into special shapes. They are available in thicknesses from .003" to .008" in straight-cut rolls or bias cut strips in 51" lengths. Each base material is coated with Irvington special insulating varnish.

High tenacity varnished rayon is said to be the most suitable alternate for varnished silk, comparing favorably with it in strength and flexibility. It has a dielectric strength of 1,200 vpm and is used for wrapping leads, small magnetos and coils.

Varnished cotton cloth is said to have greater tensile strength than varnished silk. Its pliability permits application on odd shapes. Dielectric strength is 1,200 vpm.

Varnished nylon has qualities of flexibility and high tensile strength with dielectric strength of 1,200 vpm.

* * *

ALLIED CONTROL LOW POWER RELAYS

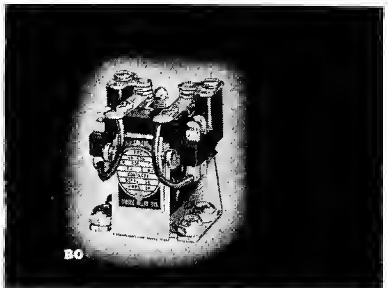
Minimum mounting space and variations in mounting bases for interchangeability are featured in the redesigned BO and BJ power relays of Allied Control Co., 227 Fulton Street, New York City. They are now available with mounting bases of bakelite, screw or shake-proof nut, etc.

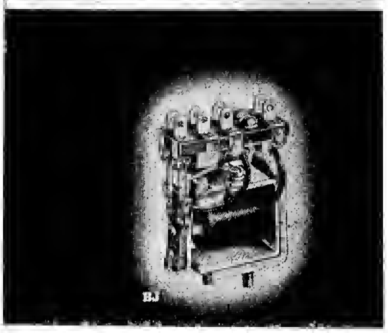
A semi-balanced armature to withstand vibratory motion with minimum coil power is also a feature.

The specifications of the BO are . . . contact ratings, non-inductive, 15 amperes for 12 and 24 volts d-c and 110 volts a-c; single or double pole, double throw; weights, 4 ounces with screw or shake-proof nut mounting or 7 ounces with bakelite mounting (model BOB in bakelite); withstands vibratory motion to 12G with 2½ watt operating power; operates at temperatures of +70° C., or —50° C.; dimensions (screw or shake-proof nut),

1⅝"x1 17/32"x1⅞" (bakelite mounting, model BOB . . . 2⅝"x1⅞"x2 3/16").

The specifications for the BJ are . . . contact ratings, non-inductive, 5 amperes for 12 and 24 volts d-c and 110 volts a-c; single or double pole, double throw; weights, 2¼ ounces with screw stud mounting or 5¼ ounces with bakelite mounting (model BJB in bakelite); withstands vibratory motion to 12G with 2 watts operating power; operates at temperatures of +70° C. or —50° C.; dimensions (screw stud mounting) 2 5/16"x11/16"x1 9/16" (bakelite mounting, model BJB, 2 7/16"x 1 11/16"x1 15/16.".





* * *

SYNTHETIC WHITE SAPPHIRE

Synthetic white sapphire, the mineral corundum unpigmented and said to be of gem quality, is now available in the form of boules from The Linde Air Products Company, a unit of Union Carbide and Carbon Corporation, 30 East 42d Street, New York City. The boules, the form in which the sapphire is manufactured, each weigh at least 150 carats and are of a regular cylindrical shape, enabling gem cutters to standardize on cutting and sawing procedures. The material, as now made, is said to be practically perfect.

Mineralogically, the hardness of the American white sapphire is exceeded only by the diamond. Once they are cut, the jewels are also surprisingly tough in terms of resistance to breakage by impact. Moreover, because they have a melting point of over 3,700 deg. F., they are also heat resistant to a high degree. An additional advantage is the boules' uniformity of size and shape, which leads to economical cutting.

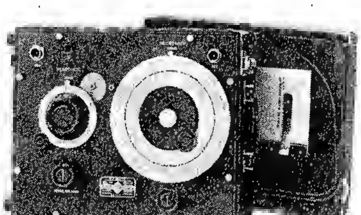
* * *

400 KC-60MC RF BRIDGE

A radio-frequency bridge designed to measure the resistance and reactance of antennas, transmission lines and circuit elements at frequencies between 400 kilocycles and 60 megacycles is now available from General Radio Co., 30 State St. Cambridge, Mass.

Through the use of a new bridge circuit the resistance dial is made direct-reading in ohms at all frequencies. The reactance dial is calibrated in ohms at 1 megacycle.

The resistance range is 0 to 1000 ohms; the reactance range—5000 to +5000 ohms at 1 megacycle. The accuracy of measurement is said to be ±2% ±1 ohm for reactance, and ±1% ±0.1 ohms for resistance.



Accessories required are a suitable radio-frequency oscillator or signal generator to supply bridge power and a well-shielded radio receiver for use as a detector.

The bridge is mounted in an airplane-luggage type of case with carrying handles. Accessories, such as leads, connecting cables, and instruction book are stored in the cover. Overall dimensions are 17 x 13½ x 11⅛ inches; net weight, 35 lbs.

* * *

LIMITED SPACE RELAYS

Compact remote control relays adapted to applications within their ratings where space is limited, have been announced by Ward Leonard.

These relays known as bulletins 104 type, are available for operation on a-c and d-c circuits. Standard relays are of the open type, with front connected solder type

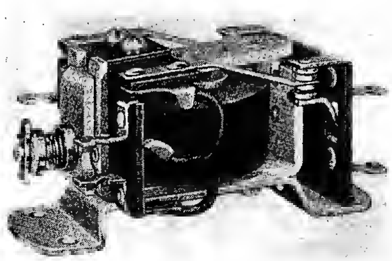
(*Continued on page* 52)

THE INDUSTRY OFFERS . . . —

(*Continued from page* 51)

terminals, double pole, double throw, silver-to- silver contacts. Contacts are rated as 4 amperes up to 24 volts a-c or d-c and 4 amperes a-c; 1 ampere d-c from 25 to 115 volts.

They are said to be vibration resistant up to ten times gravity in the energized position. The overall height from base to armature is 1-¼ inches.



* * *

SPLIT SHELL CABLE CONNECTOR

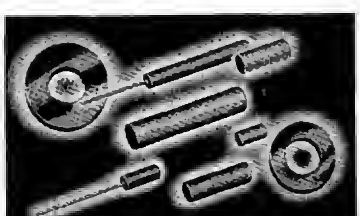
An electrical cable connector that eliminates one coupling nut and one barrel, providing a three-piece, split-shell construction is now in production at The Harwood Co., 747 N. Highland Ave., Los Angeles, California.

Entirely of die-cast construction, this new simplified connector is said to conform in all respects to Army-Navy specifications. A complete range of Harwood connectors from sizes 10S to 48 is offered in the three-piece construction.

* * *

STACKPOLE 150-175 MC IRON CORES

New materials recently developed by the Stackpole Carbon Company of St. Marys, Pa. have resulted in the introduction of molded iron cores which are said to show



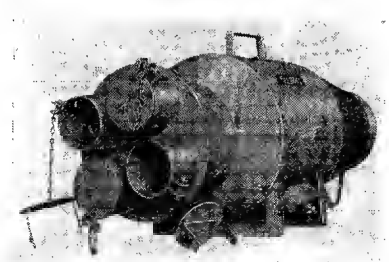
outstandingly favorable characteristics at frequencies as high as 150 to 175 megacycles. A permeability of approximately 5 with a high Q are among the other features of this new material.

Engineering details on any type will gladly be sent upon request.

* * *

EXHAUSTER AND BLOWER

A small portable unit, the Octopus, Jr., to eliminate gases, fumes, etc., from closed-in areas, such as vaults and basements, has



been produced by the Chelsea Fan and Blower Co., Inc., 1206 Grove St., Irvington, N. J.

Powered by a ¾ hp ball bearing motor, heavy steel wheels, the device sucks or

(*Continued on page* 53)

THE INDUSTRY OFFERS...—

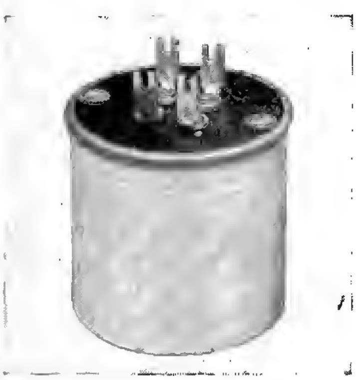
(*Continued from page* 52)

blows 2000 cfm. It operates in any position. Its weight is 70 pounds. Adapters for three-4" nozzles or four-3" nozzles for flexible hose, with caps to close nozzles not in use. Each 4" metal hose of 20 foot lengths will exhaust 250 cfm and each 3" hose over 200 cfm.

* * *

HUMIDITY-TREATED TRANSFORMERS

Thermatite treated transformers, which are said to constantly withstand extreme conditions of humidity and heat have been announced by the Thermador Electrical Manufacturing Company, Los Angeles, Calif.

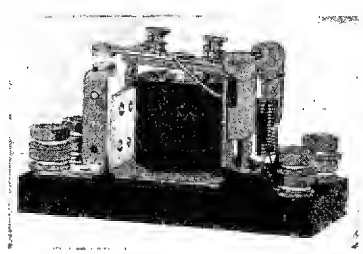


* * *

10G AIRCRAFT RELAY

A relay, the B-2-A, built to U. S. Army Air Force specifications, with a contact rating of 25 amperes continous and 100 amperes surge at 24 volts d-c has been developed by Guardian Electric, 1623 West Walnut Street, Chicago , Ill. It has single pole, single throw, normally open contacts, and weighs 6 ounces.

An acceleration and vibration resistance of over 10 times gravity is claimed. Metal parts are heavily plated to withstand 200-hour salt spray tests. Descriptive bulletins and full details are available.



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N E W S B R I E F S

(*Continued from page* 49)

HENRY JOHNSON NOW ENSIGN

Henry C. L. Johnson, radio tube advertising manager of Sylvania Electric Products, Inc., has been re-commissioned an ensign in the United States Navy. He has been granted a leave of absence from his post at Sylvannia.

Mr. Johnson has been associated with the Sylvannia organization for five years. He was graduated in 1932 from Northwestern University, and upon his graduation he was commissioned an ensign in the Naval Reserve. He served on the battleship Wyoming and on the destroyer Fairfax.

* * *

GOULD-MOODY ISSUES TRANSCRIPTION DATA FOLDER

The fourteen standards adopted by the National Association of Broadcasters for electrical transcriptions and recordings for broadcasting, are included in an attractive folder recently published by Gould-Moody Company, 395 Broadway, New York City. Copies are free for the asking.

* * *

20TH EDITION OF AMATEUR HANDBOOK AVAILABLE

The 1943 edition of the Radio Amateur's Handbook, recently issued, by the American Radio Relay League, contains 592 pages, with approximately 700 illustrations and 100 charts. Additional data included in this new issue are a chapter on the WERS, and another on microwave oscillators for use in the 200 to 570 mc region. Like its predecessors, the price of this manual is $1.00 in a paper cover.

* * *

ELECTRIC TOOL DATA SHEETS

In new bulletins released by the Ideal Commutator Dresser Company, Sycamore, Ill., an electric marker and brazer for use with silver solder are described. The marker is said to be usable on a variety of metals, porcelains, glass and woods. The brazer can be used, according to the manufacturer, to make lapp, butt, scarf and cable joints. Copies of the bulletins are available from the manufacturer.

BOOK TALK . . .

ULTRA-HIGH-FREQUENCY TECHNIQUES

By *J. E. Brainerd (Editor)*, Professor in Moore School of Electricol Engineering, University of Pa.; *Glenn Koehler*, Assistant Professor of Electrical Engineering, University of Wisconsin; *Herbert J. Reich*, Professor of Electrical Engineering, University of Illinois and *L. E Woodruff*, Assistont Professor of Electrical Engineering, Massachusetts Institute of Technology. . . . 534 pp. . . . New York: D. Von Nostrond Company, Inc. . . . $4.50.

This is an unusually comprehensive volume. It was prepared in strict accordance with an outline discussed at a meeting held at MIT, that was held to prepare an effective training program, and affords an illuminating study of u-h-f today.

Prepared by four specialists, u-h-f topics discussed are linear circuit analysis, fundamentals of tubes (power supplies), amplification, trigger circuits (Gates), pulse-sharpening circuits and oscillators, cathode-ray tubes and circuits, modulation, demodulation (detection), radio receivers, transmitters, ultra-high-frequency generators, transmission lines, radiation, propagation and hollow wave guides.

One of the most interesting chapters in the book is the last one which provides a series of experiments that show essential phenomena and relationships. —*O. R.*

• • •

MYE TECHNICAL MANUAL

***Prepored by P. R. Mollory & Co., Inc.* . . . 392 pp. . . . Indionopolis, Ind.: P. R. Mollory & Co., Inc. . . . $2.00.**

This newest Mallory publication, available from Mallory distributors, is unlike the regularly issued Mallory radio service encyclopedias. In this new technical manual will be found thirteen chapters covering essential data that every service man, engineer amateur or experimenter will welcome.

The topics covered are loud speakers and their use, superheterodyne first detectors and oscillators, half-wave and voltage doubler power supplies, vibrators and vibrator power supplics, phono-radio service details, automatic tuning, frequency modulation, television, capacitors, noise suppression, vacuum-tube voltmeters, receiving tube characteristics and general service data.

The volume is profuse with diagrams and illustrations. So that the discussions can be understood with the utmost effectiveness, commercial applications are used in many of the discussions.

The servicing information chapter contains such pertinent data as power transformer designs, milliammeter extension range charts, reactance charts, single layer inductance charts, etc. Another partion of this chapter is devoted to a complete analysis of various types of resistance-coupled amplifers.

For study or use in the laboratory or shop, this book is a "must" addition.—*O. R.*

• • •

MICROWAVE TRANSMISSION

By *J. C. Slater*, Professor of Physics, Mossochusetts Institute of Technology. . . . 310 pp. . . . New York: McGrow-Hill Book Co. . . . $3.50.

For those who want a complete analysis of transmission on the ultra-high-frequencies of 1 meter to 1 centimeter, this new volume will be found to be an appropriate answer. Topics analyzed include transmission lines, Maxwell's equations, plane waves and reflection, rectangular wave guides, general transmission line problems, antenna radiation, directive devices for antennas and coupling of coaxial lines and wave guides.

The book is not a simple study. However, in its thoroughness it does provide an accurate analysis of a complex phase of communications.

• • •

RADIO FORMULAS AND DATA BOOK

***Edited by Nelson M. Cooke*, Chief Radio Electricion, United States Navy. . . . 44 pp. . . . Chicago, Illinois: Allied Radio Corp. . . . 10c.**

A handy reference book containing most frequently required formulas and tables in use in radio today. Among

the data supplied are d-c meter formulas, inductive reactance, natural sines, co-sines, db charts, concentric transmission line formulas, etc.

• • •

NEW COMMERCIAL AND TECHNICAL DICTIONARY

Compiled by Antonio Perale Guerro. . . . 600 pp. . . . Brooklyn, N. Y.: Chemical Publishing Company. . . . $10.00.

A unique reference work containing over 45,000 words that are in constant use by the engineer. The book is divided into two sections. One is devoted to Spanish and English translations, while the other is devoted to English and Spanish translations, with of course, explanations of the words.

The volume can be considered as an authoritative one since the words have been checked in accordance with a format employed by the Royal Spanish Academy of Languages.

In addition to the dictionary portion of this book, there is a section devoted to conversion tables that will be found most helpful.—*O. R.*

• • •

THE FUTURE OF TELEVISION

By Orrin E. Dunlap, Jr., Manager of Department of Information, RCA. . . . 194 pp. . . . New York: Harper and Bros. . . . $2.50.

An interesting non-technical discussion of television and its possibilities is presented in this new volume by Mr. Dunlap. Although of the non-technical nature, the text should nevertheless be of interest to engineers and the technical-minded. It sketches, for instance, the historical evolution of television; analyzes the problems of the theatre and television, and such other television problems as . . . television in the home, television and the movies, news telecasts and sports, television schooling, the camera and television, the cathode ray, etc.

Mr. Dunlap has a masterful manner of presenting explanations of complex subjects in an effective, simple manner. Here again he demonstrates this ability, resulting in a book that is extremely instructive and yet not pedantic.—*O. R.*

• • •

BASIC RADIO

By J. Barton Hoag, Professor (T) with rank of Lieutenant-Commander U.S.C.G., Head of the Science Department, U. S. Coast Guard. . . . 380 pp. . New York: D. Van Nostrand Co., Inc. . . . $3.25.

A fundamental book that is written in a lucid and methodical style. All mathematics are treated in the simplest arithmetical manner.

Topics include . . . the electron, metallic conductors, capacitance and inductance, alternating currents, resonant circuits, high-vacuum diodes, diode rectifiers, photoelectric cells, gas-filled tubes, oscilloscopes, class A, B and C amplifiers, r-f amplifier modulation, f-m, direction finders, long lines, short lines, u-h-f transmitters and receivers, microwaves, and a section devoted to questions and answers. There are over 400 problems in this section that have been furnished with the cooperation of Mr. Redington, instructor in charge, radio engineering and maintenance school, U. S. Coast Guard.—*O. R.*

• • •

INDUSTRIAL GUARD'S MANUAL

By Harry Desmond Farren. . . . 95 pp. . . . Deep River, Conn.: National Foremen's Institute, Inc. . . . $1.25.

One of the handiest books that has appeared in a long while. It covers such pertinent topics as public and worker contact; riots, panic, mobs and crowd behavior; self-protection; first aid; fire protection; sabotage and espionage, plant protection, and bombs and internal machines.

For plant managers or factory executives, this book is ideal. It provides the data that are so essential today.—*O. R.*

Index to Advertisers

NOTICE

Inductions into the armed forces and demands of war production industries have created shortages of labor necessary in the printing, handling and mailing of publications.

If your monthly copy of COMMUNICATIONS should be late in reaching you — remember that the delay is due to war conditions and the war effort must come first.

Please bear with us.

Thank You!

GENERAL RADIO COMPANY

FOUNDED 1915

Manufacturers of RADIO AND ELECTRICAL LABORATORY APPARATUS

CABLE ADDRESS, GENRADCO, BOSTON
BENTLEY'S CODE
TELEPHONE TROWBRIDGE 4400

THIRTY STATE STREET
CAMBRIDGE, MASSACHUSETTS

TO USERS OF
GENERAL RADIO INSTRUMENTS

Gentlemen:

When instruments, built for intermittent service, are worked "around the clock" -- when years of normal instrument operation are compressed into a few months -- prompt repair service is essential. There must be no avoidable interruption of urgent war production.

Our service department is organized and equipped to handle today's unprecedented volume of service problems promptly and capably. Years of experience with adjustments and repairs have long since convinced us of the importance of service. Today this service is doubly necessary. A complete case history file is kept on every major instrument. Reconditioned instruments are guaranteed for one year to the same specifications as when new.

You can help to speed necessary repairs by doing all possible repair work in your own plant with the aid of our SERVICE AND MAINTENANCE NOTES. They have already helped hundreds of General Radio customers to cut down returns for repairs, to save valuable production time, and to get better service from their equipment.

When requesting your set of SERVICE AND MAINTENANCE NOTES, please list your General Radio instruments by type number and serial number.

Sincerely

H. H. Dawes

Service Manager

Don't Be Without the NEW MYE TECHNICAL MANUAL

This practical book is designed for the radio serviceman, engineer, amateur or experimenter. It gives both radio theory and practice—presenting the latest technical information in simple terms that you can easily apply to everyday problems. Note the table of contents below—

TABLE OF CONTENTS

1. LOUD SPEAKERS AND THEIR USE
Written by outstanding experts in the design and application of loud speakers. Covers the acoustical properties of various designs. Tells in detail how loud speakers may be selected and installed for greatest economy and best performance. New information . . . never before published.

2. SUPERHETERODYNE FIRST DETECTORS AND OSCILLATORS
The heart of a superheterodyne is its first detector. Many receiver problems involve more than just voltmeter readings. This chapter makes servicing easier by presenting the basic principles governing first detectors and oscillators. It covers *all* modern conversion systems.

3. HALF-WAVE AND VOLTAGE DOUBLER POWER SUPPLIES
Explaining the power supply design in AC-DC and series heater type receivers and amplifiers. Contains facts with which every serviceman should be familiar. Explains the "mystery" breakdowns encountered in actual practice.

4. VIBRATORS AND VIBRATOR POWER SUPPLIES
Complete, up-to-date information on the operating conditions and application of both vibrators and vibrator power supplies. Important facts about their design, and the requirements for satisfactory performance of vibrator-operated equipment.

5. PHONO-RADIO SERVICE DATA
Understanding of the mechanical and electrical principles involved makes servicing easier, quicker and more profitable. This chapter "tells all" . . . and has been called priceless by servicemen who have previewed it.

6. AUTOMATIC TUNING
In this section is a full description of the various systems of automatic tuning . . . how they work and how to adjust them. Every serviceman will profit from the information given here, since he'll use it constantly.

7. FREQUENCY MODULATION
Clear, concise, easy to read, this chapter provides a simple explanation of the design principles and operating conditions involved in FM circuits. It provides a solid foundation of knowledge for servicemen, radio engineers, amateurs and experimenters . . . anyone concerned with the practical applications of FM.

8. TELEVISION
This section provides the basic information needed to prepare for successful work in the television boom that is sure to follow the war. Understanding television now will pay dividends later.

9. CAPACITORS
Wartime servicing depends on making the best use of available components. This article shows how to install condensers for specific applications, without being dependent on duplicate replacements. Reading this article will help you make repairs promptly and assure your customers of satisfactory service.

10. PRACTICAL RADIO NOISE SUPPRESSION
You can easily become an expert on radio noise by applying the information provided in this chapter. New, down-to-earth, field-proven methods of solving practically any noise problem . . . How and where to use noise filters and much other data. Interestingly written, easy to understand.

11. VACUUM TUBE VOLTMETERS
This measuring device is proving increasingly useful in both radio work and industrial electronics. Here's a full explanation of how commercial vacuum tube voltmeters operate.

12. USEFUL SERVICING INFORMATION
All the general references a serviceman needs . . . tables, coding data, standards, design charts, etc. *Everyone* interested in radio will have frequent occasion to use this section.

13. RECEIVING TUBE CHARACTERISTICS
Complete tables covering all American tube types. Arranged in convenient form to save you time.

392 pages, 8½ x 11 inches, with valuable information much of which has never before been available. Profusely and accurately illustrated. The New MYE TECHNICAL MANUAL is durably bound in hard cloth covers with permanent sewed binding. Go to your nearest Mallory Distributor and buy this de luxe edition at the net price to radio servicemen—$2.00.

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